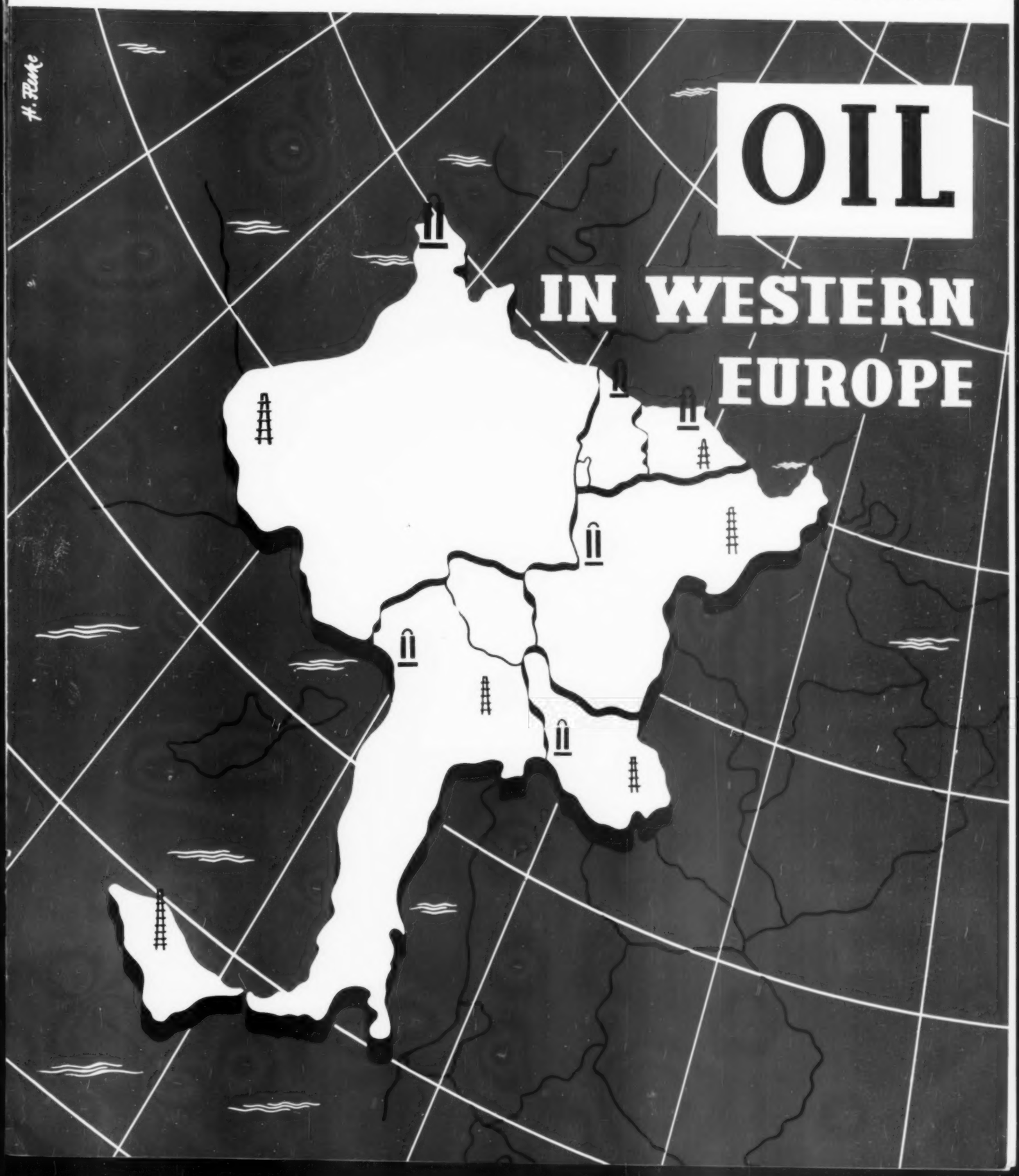
WORLD PETROLEUM
IN TWO SECTIONS • SECTION II
JUNE 1959



OIL IN WESTERN EUROPE

Participating countries in this report on Oil In Western Europe

Austria
Belgium
France
Germany
Holland
Italy

Oil in Western Europe

In the fourteen years since the close of World War II Western Europe has shown remarkable vitality. The ravages of war have been largely repaired and new production facilities have been built to supply the needs of a growing population.

Living standards in Western Europe have undergone a marked change in the post-war era. Motor cars are crowding the fine new country roads. Buzzbikes are vieing with bicycles for space on the cyclepaths. Homes are being equipped with television, electric refrigerators and labor saving devices. Human energy is being supplemented to a greater degree with energy drawn from the earth's storehouses.

Energy demands for manufacturing, transportation and the home have been expanding at a time when water power has been largely put to use and at a time when coal has become too difficult to mine or too expensive. Oil has filled the gap at an increasingly accelerated rate since the Fourth World Petroleum Congress met at Rome four years ago. The effect of economic integration and the breaking down of artificial trade barriers is expected to increase this tempo in the next four years before the Congress meets again.

As pointed out in Section I of this issue of WORLD PETROLEUM, the oil industry had its first opportunity to grow because of the high cost of whale oil for illumination a century ago. Today, with atomic energy still a generation or so away as a major source of power, the petroleum industry faces a new era of great expansion because it has developed adequate reserves which it is able to produce at low cost.

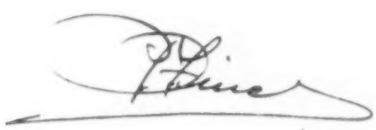
As the Fifth World Petroleum Congress meets in New York to celebrate oil's centennial, to consider the present status of the industry and to look ahead at prospects for the next century, the editors of WORLD PETROLEUM take pleasure in presenting this volume titled "Oil in Western Europe." In this section the editors have sought to catch the present spirit of the European Community and to give an idea of what is ahead as well as to picture recent progress. The study reveals that oil is young and vigorous at 100, that the coal age is waning in Europe while petroleum has a bright destiny to fulfill its service to mankind.

IT was in 1957 that the Ministries of Foreign Affairs of France, Germany, Netherlands, Belgium and Luxemburg, entrusted the E.C.S.C. High Authority to examine the best methods of promoting a coordinate policy in the field of energy.

Indeed, the progressive integration of oil and natural gas and later of nuclear energy in an industrial area for which coal remained, however, the main source of energy, made it indispensable that the energetic policy of the countries belonging to the Community should be coordinated. The High Authority, which is directly responsible for the coal policy of our six countries could not truly fulfill its mission without including it within general considerations on energy.

It has, at first, to assure to all sections of economic activity the advantage of high productivity which results from the use of the most economical sources of energy. It must, however, avoid the ill effects which could, in the short run, result for existing industries and for labor from the brutal effects in the relative development of the utilization of the various energies. The purpose is to avoid the misdirection of long term investments.

The article on a following page titled "Trends of Oil Economics and Their Influence on the European Energy Market" tries to analyze the factors which will determine in the long run, the conditions in which oil could be offered to the countries of the Community and their effects on the market of other sources of energy, particularly that of the coal.



PRESIDENT DE LA HAUTE AUTORITE DE LA COMMUNAUTE EUROPEENNE DU CHARBON ET DE L'ACIER.

The Federation of Petroleum Equipment Manufacturers

by J. P. Le Gall
Secretary-General of the Federation
of European Petroleum Equipment Manufacturers
Paris

THE petroleum industry has old-established roots in Europe. Crude oil production figures go back as far as 1857, while many of the earliest refining methods were developed by European chemists who became famous for their pioneering work.

By late in the 19th Century powerful industrial groups in Holland, Belgium, England, France and Germany had become active in developing European sources of crude and many of those companies were extending their oil-search activities outside Europe, even as far afield as the islands of the Malayan Archipelago.

Naturally the two world wars in the first half of the 20th century retarded European participation in the development of the oil industry, and over a period when development was vastly stimulated in the United States and Latin America, particularly to meet the needs of war.

This does not mean that the European industry was not fully alive to the importance of this great development. In the decade 1930–1940 refinery construction programs attained a scale of considerable magnitude in several European countries, and since the end of World War II spectacular progress has been made.

The total refining capacity of the 17 members of O.E.E.C. (Organization for European Economic Cooperation) has risen from 200,000 b/d in 1949 by leaps and bounds to a total of 2,700,000 b/d in 1957. The end of this spectacular rise is by no means yet in sight. It is expected that Western European energy requirements will increase by 60% between 1955 and 1975, and from O.E.E.C. oil committee estimates it appears that the share met by petroleum will rise from 19% to at least 32% over this period.

To make this petroleum available will mean an investment by the industry of some $20,000 millions. A large proportion of this will relate to plant and equipment required by the oil companies which will be made almost entirely by European firms. As a matter of fact, these can fabricate about 80% to 85% of the prospecting, drilling and exploitation equipment needed, and about 95% of the refinery equipment. As regards transport, all the requirements are obtainable in Europe.

The oil industry being of so international a character, it was only natural that the equipment manufacturers should have become interested in international cooperation. Further, there was another important consideration—the growing feeling among western European nations that much closer cooperation was essential to meet the needs of a changing world. It might mean a matter of economic life or death.

While the patchwork of large and small economic states that forms western Europe, and the fierce competition this engenders, has undoubtedly furthered economic progress, at the same time the principle of absolute sovereignty has greatly hampered mutual development. At least one beneficial thing emerged from World War II: the essential need for closer cooperation between western Europeans in all fields of activity. There are, however, still many difficulties to be overcome, and many problems to solve, before the ideal of a truly United States of Europe can be attained, but at least the feeling is growing that this should be the ultimate aim.

It was considerations such as these which promoted the formation of the Federation of European Petroleum Equipment Manufacturers (F.E.P.E.M.) on December 9, 1953, in Paris. The founder member countries were Belgium, France, Germany, Italy, the Netherlands, and the United Kingdom, with Austria joining in 1958.

The seeds, so to speak, of F.E.P.E.M. were sown in 1951 at the Third World Petroleum Congress at The Hague, when the following resolution was approved:

"The members of the Third World Petroleum Congress strongly recommend the formation of a coordinating committee for western Europe, including the United Kingdom, to cooperate with the national organizations for the usage and standardization of equipment for the petroleum industry in order to establish uniform international standards. They recommend that countries be encouraged to form national organizations where these do not exist."

Similar recommendations were made by experts from the oil and equipment industries who participated in study missions in the United States and in Europe in 1951 and 1953 respectively.

F.E.P.E.M. came into existence as an organization patterned on the Council of British Manufacturers of Petroleum Equip-

ment (C.B.M.P.E.) "and in fact, the eleven years' experience of the latter has been freely drawn upon in all negotiations not only leading to the formation of the Federation, but also for its subsequent operations."

The words quoted were those used by the first president of F.E.P.E.M., the late Douglas Wilson (U.K.), in a booklet introducing the federation to members of the Fourth World Petroleum Congress, in Rome in 1955. And ever since then C.B.M.P.E. has given F.E.P.E.M. its full support and the benefit of its wide experience.

The two basic concepts for the equipment manufacturers can be summed up thus:

1. His production is a specialty in its own right. Managers and their technical staff must acquire the habit of being "oil-minded."

2. The manufacturer must always realize that, whatever his scale of operations, it will be a full-time task to keep in step with the technological developments and the equipment requirements of a dynamic industry which is constantly in a state of progressive change and evolution.

So far as cooperation outside the manufacturer's own immediate orbit is concerned, this must be maintained in at least the following four distinct ways: (a) cooperation between the various equipment manufacturers (including the metallurgists); (b) cooperation between the equipment manufacturers and the oil companies; (c) cooperation between the equipment manufacturers and research organizations; and (d) cooperation with scientific bodies.

The formation of F.E.P.E.M. on these bases represented a significant and progressive step in this field of European industry and one which it is hoped, and believed, will have far-reaching results. The present national councils and the addresses of their secretariats are:

Austria—Fachverband der Maschinen—und Stahl u. Eisenbauindustrie Osterreichs. Bauernmarkt, 13, WIEN I. Telephone: 63 2761.

Belgium—Comité Belge des Constructeurs d'Equipement Pétrolier (COBECEP), 21 rue des Drapiers, Bruxelles. Telephone: 11 23 70.

France—Groupement Intersyndical des Fournisseurs de Matériels d'Equipement pour l'Industrie du Pétrole, 10 Avenue Hoche, Paris 8è. Telephone: Mac-Mahon 38-00.

Germany—Fachgemeinschaft Apparatebau im Verein Deutscher Maschinenbauanstalten e.v. (V.D.M.A.), Lueg-Allee 65, Düsseldorf-Oberkassel. Telephone: 5 40 21.

Italy—Unione Costruttori Impianti per Trivellazioni e per l'Industria del Petrolio e del Metano (A.N.I.M.A.), Piazza Diaz 2, Milano. Telephone: 80 28 41.

Netherlands—Netherlands Oil Equipment Manufacturers (N.O.E.M.), Nassaulaan 13, The Hague. Telephone: 18 45 90.

United Kingdom—Council of British Manufacturers of Petroleum Equipment (C.B.M.P.E.), 2 Princes Row, Buckingham Palace Road, London, S.W.1. Telephone: Victoria 0017/19.

The history, membership and stature of the national organizations vary according to the size and character of the equipment industry in the various countries, its general economic pattern, and the part it plays in the petroleum industry. They all, however, have the common character of being non-trading organizations and in accepting as members only those firms known to be serving the oil industry and considered as reliable. All these organizations issue catalogs at regular intervals which show clearly what western European firms can do to meet the demands of the world petroleum industry.

The notes which follow on the individual national groups, in alphabetical order, will serve as an indication of the size and importance of the petroleum equipment industries in the countries concerned.

Austria

Around the turn of the century the Austro-Hungarian empire played a leading part in European oil, not only as a producer of crude oil in the Galician foothills of the Carpathians, but also as a supplier of oilfield machinery and refinery equipment. The petroleum industry of Austria as well as in Romania in those days was dependent to a great extent on the equipment industry of Austria for its requirements.

World War I and the consequent breakup of the Austro-Hungarian empire naturally dealt a terrific blow to that section of the equipment industry which was located in Austria proper, the part that became the Austrian Republic. Fortunately, however, the very small prewar oil production in Austria was increased considerably by reason of successful exploratory programs in the period between the two world wars. The country's equipment industry thus benefited to a great extent from the growing importance of indigenous crude production; furthermore, it still played an important part in meeting the ever-increasing equipment needs of Romania's oil industry.

The Austrian equipment industry met its second serious setback from World War II and even more from the fact that for a number of years the oil fields were under foreign control. The fields were only handed back to the Austrian government with the signing of the State Treaty in 1955 between the Allied Powers and the Austrian Republic. The oil equipment industry, for its part, has fully seized the opportunity thus offered to it and the Fachverband der Machinen- und Stahl u.-Eisenbauindustrie Österreichs formed a special committee on oil equipment to promote cooperation between the Austrian manufacturers as well as with other European suppliers.

Austria's oil industry is owned by the government. Crude production in 1958 averaged 60,000 barrels a day and natural gas 79,344 mm cu. ft. Refinery capacity is now 49,100 b/d but this will be doubled when the new refinery now under construction near Vienna-Schwechat is put on stream towards the end of 1960. Two petrochemical plants are being built in conjunction with this refinery. One is owned by Danubia-Petrochemie A.G. (Austrian-Italian interests) and will have 6,000 metric-ton-year design capacity of propylene, and the other belongs to Farbwerke Hochst A.G. with 3,700 metric-ton-year capacity of ethylene.

Belgium

The Belgian metal industry can look back on a long and glorious history. The valleys of the River Meuse and the River Sambre have long been known all over western Europe for the high calibre of their metal industry. The modern development that changed Belgium into one of Europe's most industrialized countries did not start very much later than England's well known industrial revolution at the beginning of the 19th century.

The country's petroleum equipment industry, however, was severely handicapped in the absence of indigenous crude production. Nor, until recently, did Belgium have overseas possessions containing oil resources. Thus, naturally, the metal fabricating industry was not likely to consider the petroleum industry as a likely field of outlet for products.

Between the two world wars, and particularly since major refineries were erected, the metal industry has realized the importance of the petroleum industry as a potential customer for its high grade products. It is for this reason that national petroleum equipment manufacturers are organized in the Comité Belge des Constructeurs d'Equipement Pétrolier as a member of Fabrimetal, the well known organization of the Belgian metal industry.

The national refining capacity, now over 150,000 b/d, will soon be stepped up and the petrochemical industry is to be expanded appreciably. The capital expenditure for these new plants is put at over Belg. francs 600 millions and the output of the various petrochemicals as around 40,000 tons per year.

France

In France there are various associations covering firms manufacturing different types of equipment. Pipe manufacturers and control instrument makers are two typical examples. In 1953, however, it was realized by these organizations that there was a need for the creation of a special association for petroleum equipment manufacturers. By 1959 the Groupement Intersyndical des Fournisseurs de Matériels d'Equipement pour l'Industrie du Pétrole numbered about 250 member-firms. Between them, they have supplied practically all the equipment for the plants built by the oil industry in France.

At present the country's refining capacity is around 630,000 b/d. This is expected to rise to 840,000 b/d in 1961 and to over 1 million in 1965. Investment in these plants

in 1958 is estimated at about Fr. Frs. 50 billion.

So far as the search for oil and gas in Metropolitan France is concerned, the Lacq gas field is expected to be yielding 4 billion m^3 in 1961 and the output of crude should reach 20 million tons per year in 1962.

For French Africa the estimate for Hassi Massaoud oil reserves are now put at 300 million tons, and by end-1960 crude will be reaching the Mediterranean at the rate of 14 million tons per year. The Edjele district is estimated to contain some 100 million tons and a pipeline is being constructed to transport 7 million tons per year to the coast. Thus by 1962 the production of crude on behalf of France will be about 20 million tons per year. In addition, Hassi R'Mel gas reserves are estimated at 800 billion m^3, and the annual production of 20 billion m^3 envisaged would correspond to half France's coal consumption.

Anticipated 1959 expenditure on oil search in France and French Africa is put at Fr. francs 250 billion: this comprises 80 billion for exploration, 35 billion for drilling development, and 100 billion for oil field equipment, pipelines and processing.

As regards petrochemicals, extensive developments have taken place in the past decade and capital investment has been running at the rate of over Fr. francs 15 billion a year over the last few years. This branch of the country's petroleum industry is destined to become of major importance. At present 21 new plants are building or in the planning stage for the production of a wide range of petrochemicals.

Germany

In the German Federal Republic there are now about 400 firms engaged in the manufacture of oil field equipment covering an almost complete range of the petroleum industry's needs. These firms are organized in different groups but the majority are also members of the Verein Deutscher Maschinenbauanstalten (VDMA), a body which embraces firms active in the metal industry.

It should cause no surprise that in such a highly industrialized country as Germany the V.D.M.A. can look back on a long history. It came into existence in November 1892 with 56 members. Its objects include the furtherance of the exchange of information on practical experience among members, to seek uniformity in business matters, and to advise the government and general public of the importance of the German industry to the well being of the country.

It is laid down explicitly that V.D.M.A. will never encroach on the freedom of its members nor pursue any political aims. Membership of V.D.M.A. is not compulsory for German firms belonging to the metal industry.

Crude oil production in the German Federal Republic has been raised from 20,000 b/d in 1939 to 80,000 b/d in 1957 thanks to the discovery of several fields in the area between the River Elbe and the River Weser in the northern part of the country. Domestic refining capacity, which was 335,000 b/d at the beginning of 1958, was increased considerably during the year and it will rise to over 600,000 b/d this year and to almost 800,000 b/d toward the end of 1960. Throughout Germany as a whole industry in general is turning increasingly from coal to oil and gas, and the petrochemical industry is developing rapidly.

Italy

In Italy, with its Unione Costruttori Impiantiper Trivellazioni e per l'Industria del Petrolio e del Metano, the metal industry has succeeded in winning a high reputation in the manufacture of drilling and production equipment and also for the construction of the wide range of plant and equipment needed by the petroleum industry. The considerable effort made by the Italian industry has proved very successful, especially when it is borne in mind how very limited were the possibilities open until relatively recently.

The founding of AGIP and its remarkable progress has naturally played a very important role in this effort. Excellent results have also been secured by AGIP Mineraria's search for oil and gas throughout Italy as well as in similar activities in other directions, more modest but not less important. Exploratory programs in the Po Valley, central and south Italy, and in Sicily have yielded fair results.

The refining industry which Italy started to create between the two world wars has now grown to a capacity of 550,000 b/d.

World War II and sabotage practically destroyed the refineries and installations on the peninsula. But Italian initiative came into play and soon after the war the oil industry's efforts were renewed and intensified to such a degree that, in a few years, an imposing array of refining plants and installations had been built as to give Italy an outstanding position in the world refining industry.

Not only were prewar plants rebuilt and modernized but new refineries were constructed at such places as Naples, Leghorn, Bari, Venice and Cortemaggoire (Piacenza). The plants of Condor, Rho (Milan), Sarpom and San Marino di Trecato (Milan) are imposing, each one being connected by pipeline with ports at the Liguria Riviera. The installations of Rasiom Augusta are also worthy of mention. Big, medium and small size firms have all played their part in this great effort; considering the relatively short time this took to achieve, the results can indeed be described as "huge".

The Netherlands

Until the beginning of the 20th century the Netherlands-or Holland as the country is generally called throughout the world—was mainly dependent on agriculture, maritime trade and hinterland trade for its existence. World War I showed the Dutch how dangerous it was to be dependent on imported industrial products. Moreover, about the turn of the century a phenomenal rise in population began which has not yet come to a halt.

For both reasons it was a dire necessity for Holland to turn to industry in order to feed an ever increasing population. The Dutch rose to the occasion. Between the two world wars they started building up an industry whose products would be competitive with those of the major industrial countries. All went well in the industrial field, though the depression and financial crisis of the thirties hampered rapid progress being made, until the fateful May 10, 1940, when the country was drawn into war.

No sooner had hostilities ceased, however, than the Dutch, with their dogged stubborness, started to repair and reequip their bombed and stripped factories, to build new plants, and to establish new high caliber research establishments so that the scientists could cooperate with the technologists and business men.

Manufacturers of petroleum equipment have played their due part in the country's industrial development. Thanks to the fact that Holland is the cradle of the Royal Netherlands Petroleum Company—the "Royal Dutch"—Dutch equipment manufacturers have good opportunity for close study of oil industry requirements. They have benefited greatly from this advantage and in 1953 a number of petroleum equipment manufacturers joined in founding a non-trading organization under the title of Netherlands Oil Equipment Manufacturers. This association now has 60 members.

Crude oil production, which was only some 1,000 b/d before the war, had risen to 28,000 b/d in 1958. Refinery capacity, now 240,000 b/d, will be raised to over 350,000 b/d towards the end of 1960. A number of petrochemical plants are in operation.

United Kingdom

The development of and the benefits that have accrued from the formation of the Council of British Manufacturers of Petroleum Equipment are, it is understood, to be the subject of a separate review. In these circumstances, all that need be said here is that the C.B.M.P.E., in the opinion of the European federation of which it forms a part, represents a very active and efficient organization.

It is undoubtedly recognized fully by government bodies, the petroleum industry, and by scientific associations in the U.K. as representing the great majority of British firms that specialize in providing equipment and services for the petroleum and petrochemical industries. Its membership is well over 400 firms and, with such a well organized body, it is not surprising that over the years 1955 to 1958 the value of orders (excluding tankers) placed by the oil companies in the U.K. with British manufacturers has averaged £ 133.3 million a year.

Trends of oil economics and their influence on the European energy market

by Lucio Corradini, Engineer
Head of the "Competing Energies" section,
Market Division of the E.C.S.C. High Authority

The substitution of new concepts for old systems in the field of economics at the end of the second world war was the cause of many changes throughout the world. In Europe this has been particularly true as far as energy is concerned. There is no doubt whatever that petroleum is at the center of these changes which apply simultaneously to demand, supply and prices.

As regards demand, we see for instance, that considered in relation to the total consumption of oil throughout the world, that United States demand fell from 70% in 1938 to 55% in 1956, while that of Western Europe (as compared with greatly increased world consumption) rose from 14 to 18%. Side by side with this lower relative consumption in the United States is the fact that for the first time the USA became a substantial importer, thus opening up wide prospects for the international oil trade. As to Europe* whose activities are traditionally centered on coal, the position now is that, with its complete economic cycle, Europe is no longer able to meet even its own requirements which were always covered by domestic coal resources in the past, and that it is more and more dependent on oil.

With regard to supply, the center of gravity of oi production tends to move from the USA Carribean Gulf to the Middle East. An estimate of reserves in the free world shows that in 1955 only 29% were held in the Western hemisphere (18.7% of which was in the USA) as against 71% (68% of which was in the Middle East) in the eastern hemisphere. This means that the future direction and volume of oil transportation between the two hemispheres will be gradually changed.

Not only is there a great abundance of oil in the Middle East, but it is exploited with exceptionally favorable productivity (about 580 t day per well), at a cost of some $3.50 to $5 per ton against $18 to $20 in USA (with about 2 t day per well).

As to the price of oil, many factors come into play to ensure the maintenance in principle of the old rule fixing the "international price."

Indeed, the price policy of the large companies is conservative, for it is influenced by the problem of long term investments, which are very considerable and variable according to the areas. Gross investments forecast for the period extending from 1955 to 1965 will amount in all to $114 billion (of which 65% will be in the United States).

With regard to the variability of investments in countries other than the United States, it is sufficient to remember that every additional ton produced calls for $100 in Canada, but only $6 in the Middle East. In support of these differences, the companies argue the necessity for flexibility and reliability of sources of supply.

This concept in the matter of price has been subject for some time to the competitive action of "independent" American and European producers who are increasing in number, (for instance, in 1955 220 American companies were operating outside the United States, as against only 20 in 1945), and becoming more and more venturesome. Action on the European market by the new "Independents" is shown not only by offers of crude at lower prices than those received by refineries connected with the "big companies", but also by the setting of a vertical structure enabling them to deal directly with the consumer.

This action which forces prices down is strengthened by the effects of the restriction on oil imports in the United States—a restriction which is being gradually accentuated under the pressure of local producers —and, on the other hand, by the continuous increase in Middle East production under the pressure of governments of the Arabian countries with a view to adding to their revenue.

These different factors may well be reinforced by the arrival on the market of oil from the USSR, whose last seven year plan provides for an increase from 113 to 230-240 million tons. When it is considered that, besides this petroleum, the production of natural gas should rise from 30 to 150 billion m^3 in Russia, it is to be expected that substantial tonnage of oil will be available for export and will weigh on the market. With the carrying out of the plan, the weight of hydrocarbons in the total production of fuel in Russia would rise from 31 to 51%, as the structure of its energy economics tends to approach that of the United States.

This is why the "international price" rule has been applied for some time with a certain degree of flexibility to supplies from the Middle East (Middle East differential). This obviously reflects a market situation which cannot be compared with the prewar situation. Moreover, quite apart from the recent scission between the Eastern hemisphere price and the "international price", Europe pays about $5 less for Middle East oil than for that shipped from the Caribbean, owing to its geographical situation.

The success of recent prospecting in the Sahara, which can be considered the sign of further important discoveries, will only strengthen the tendency of Europe to obtain its supplies (on the favorable terms which can be imagined) in her own hemisphere. Of course for technical and economic reasons a certain amount of cross haul will take place with crude and products of the Western hemisphere in the future.

To form an opinion of the part played by oil on the energy market of Western Europe, it should first be remembered that, in relation to the internal consumption of energy, net imports increased from 3% in 1937 to 20% in 1955 and that today oil represents some 80% of fuel imports. (See Table I) This definitely shows the growing disparity between internal consumption and production.

Compared with Europe as a whole, the

* the O.E.E.C. countries as a whole.

TABLE I

Energy consumption, West European production of primary energy, and net imports into OEEC countries in millions of tons, coal equivalent 7,000 Kcal/kg

	1937	1950	1955
Internal consumption	563.0	602.5	730
Production of primary energy	546.9	533.7	584
Net imports	16.1	68.8	146
Total imports split up into:			
Total coal imports of which	12.1	10.5	29
American coal represents	(0.0)	(0.4)	(24)
Crude oil, including bunker oil	—	37.8	117

energy consumption of the member countries of the Coal and Steel Community exceeds 50% and their net imports approximate 60%.

As it is impossible to deal with expansion of oil consumption without comparing it with that of the other chief sources of energy, it seems advisable to draw up Table II as a recapitulation of the relative consumption of primary energy fuels, such as coal, petroleum and natural gas, in a few large consuming sectors of the Community and the United States where these fuels compete with one another. Figures in the tabulation are exclusive of specific uses of any one source of energy—for instance, that of coke in iron and steel production, of gasoline and gas oil in engines, etc.

TABLE II RELATIVE CONSUMPTION OF PRIMARY FUELS

(Reference year: 1956)

Sectors	Products[1]	Community %	United States %
Electric power stations	C	91	70
Gas works	P	6	9
	G	3	21
Industry, including iron and steel	C	65	32
	P	29	16
	G	6	52
Domestic uses, including small trades and crafts	C[2]	86	16
	P	13	41
	G	1	43

[1] C—coal; P—black petroleum products (gas and diesel oil + residual fuel); G—natural gas.
[2] Including coke and lignite briquettes.

The figures in Table II call for a few comments:

1. In the Community, the greater consumption of oil by the "Industry" sector is apparently due to a limited availability of natural gas, which would help to explain, partly at least, the fundamental difference in the respective structures of oil consumption in the two areas under consideration.*

2. Coal maintains its predominant position for the supply of electric power stations, both in the United States and in the Community.

3. Striking differences appear in the "industry" and "domestic uses" sectors. In the United States, contrary to the situation in the Community, only small use is made of coal (32% and 16%, as against 65% and 86%, respectively).

	Gasoline	Intermediate distillates	Residual fuels	Other products
ESCS	22%	23%	42%	13%
USA	43%	25%	17.5%	14.5%

While it would be rash to merely transpose the *de facto* situation observed in the United States to the Community, it can scarcely be imagined that no great changes of structure will occur in both these sectors in the long run.

Admitting, therefore, that the integration of petroleum is to be expected, it must nevertheless take place without any sudden jolts even if the economic situation of coal is unfavorable. Among other advantages this will permit a better utilization of production capacity both in the field of oil and in that of coal, and avoid investments being directed into the wrong channels. When the problem is considered from this angle, it will more readily be examined in connection with the large sectors of consumption, where the importance and quality of the products dealt with, the characteristics of the apparatus in which they are used, the consumer's attitude, etc. are so many decisive factors.

In the domestic sector, we find that oil calories, although usually more expensive than coal calories, become of interest from the point of view of comfort. Furthermore, due to the conditions governing consumption, the use of oil in this sector is not developing as quickly as it is in industry where price is one of the essential factors.

As, in principle, refineries are built on the coast, geographical lines of defense are favorable to coal whenever no consideration need be given to the special advantages attaching to the use of oil in the matter of combustion, labor, productivity, etc. This applies, in particular, to most thermal power stations situated inland.

As regards the future development of oil consumption in the Community countries, the possibility of adapting the data resulting from the structure of the American consumer market is dependent on the countries concerned being able to improve their standard living, and on the use of petroleum being more economical than that of coal. It should also be remembered that the supply of gas from the Sahara may in some cases allow a choice between oil and gas*. Now, it is to be expected that, particularly as a result of economic integration, the standard of living will gradually improve in the member countries of the Community.

As to the comparative evolution of the prices of the two fuels under consideration, it can reasonably be assumed that on the whole, and taking account of the expected output per shift in relation to the rate of increase in productivity in other economic sectors, the price of E.C.S.C. coal will increase.

On the other hand, as far as oil is concerned, in the light of factors which already influence the "international price" it is to be expected that, even under the least favorable conditions, its price will remain practically unchanged, which means that the difference in price between coal and oil will follow an ascending curve.

The planned extension of the pipelines starting from the Mediterranean coast (Marseilles to Strasbourg and Cologne—Genoa to Aigle, Switzerland, and probably Venice or Trieste to Munich) clearly shows that new oil distribution centers will be created within the Community itself, and that they will be added to by those which will be required for Sahara gas.

It may well be, therefore, that a long term change will take place in the distribution of centers of energy. The southern areas of the Community, nearer to oil supplies, will evolve on entirely new lines. There are already many signs of such a movement of industry. Among the numerous projects under consideration or in course of execution, we can mention by way of example that an important chemical combine has just decided to erect one of the largest petrochemical works in Europe (proposed investment $120 million) at the southern extremity of Italy, that is to say opposite the Middle East oil fields.

Faced with such prospects, its seems obvious that the long-term position of the coal market will have to be reconsidered. America has already had to deal with this problem and Russia seems to be following the same course. The experience of these two countries points clearly to the sectors where coal will unavoidably find its principal market.

The extent to which it will be realized that such economic phenomena are irreversible and must be faced with determination and objectivity, and dealt with by long-term measures, will enable many difficulties to be overcome.

We may conclude on the basis of this short analysis that numerous factors completely change the bases of the problem of limiting imports through the application of an accelerated nuclear program, which means that the economics of such a program must be measured on the "petroleum level" and not on the "coal level." These factors are:

1. The enormous reserves of petroleum and natural gas at the very doors of the Community, most probably available at advantageous prices.

2. The necessity for the Community, which is drastically committed to long-term economic competition, to profit by the productivity advantages offered by the use of oil in several sectors of industry.

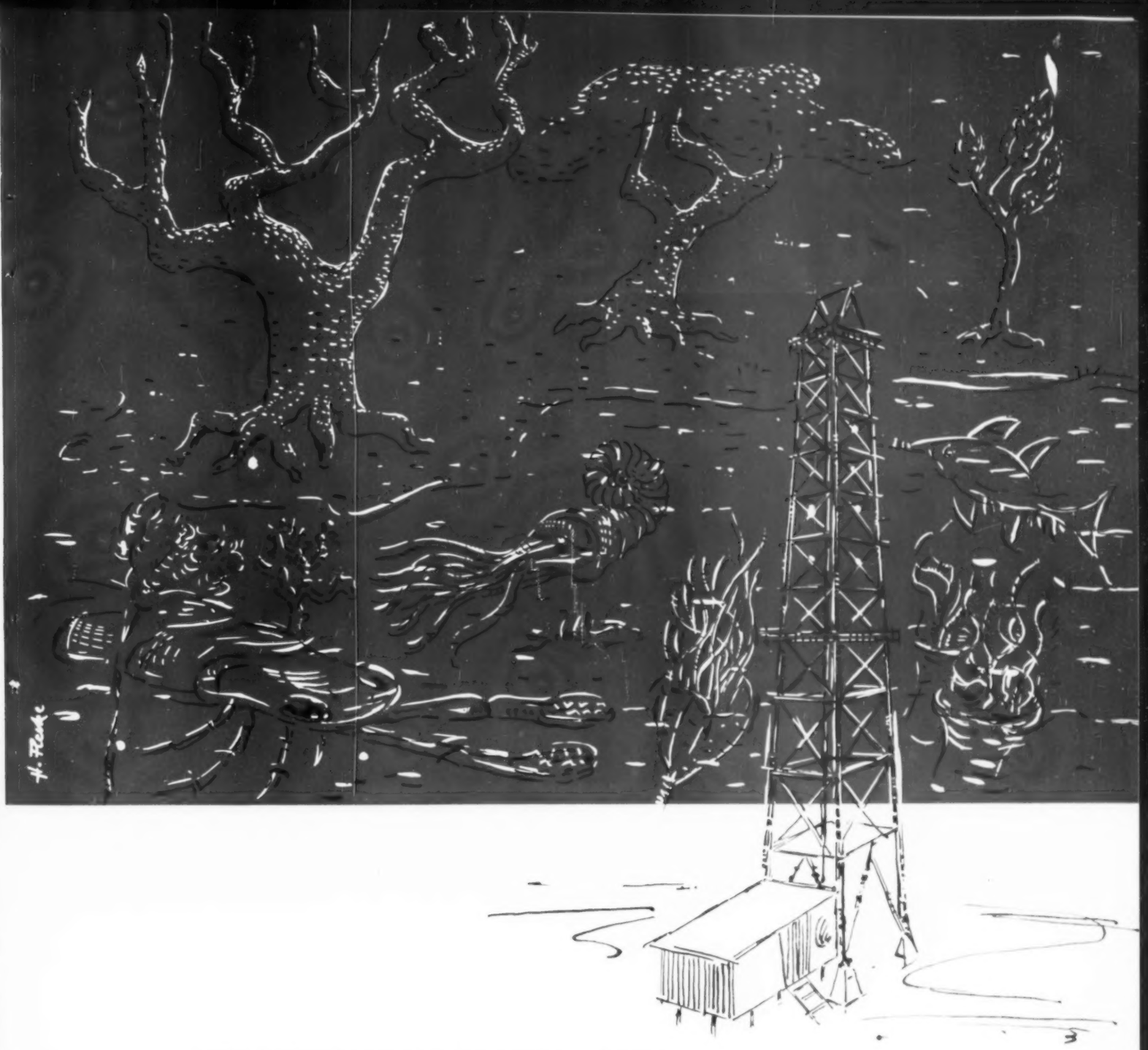
3. The unlimited investments necessary to meet the requirements of the Common Market.

4. The necessity to institute freedom in the exchange market in order to assure the economic expansion of the Community, which by its very structure is short of sources of energy and essentially engaged in the processing of raw materials.

5. The economic interdependence to be anticipated between industrialized countries and underdeveloped, but oil producing countries.

This is the viewpoint from which oil will play the part assigned to it in our era, which is to act as a hyphen between coal and nuclear energy.

* This might involve a change in the present refining pattern.



AUSTRIA

INTRODUCTION by Dr. jur. Fritz Bock, Federal Minister of Trade and Reconstruction

With a yield of 2,836,396 tons of crude oil and 820,285,900 NM^3 of natural gas in 1958, and with an employment strength of approximately 12,000 persons, the oil industry represents a considerable factor in the Austrian economy. This branch of industry, however, is subject to reparation deliveries to Russia which amount to 1 million tons of crude oil per annum, for a period of ten years; on the other hand, a quantity of 500,000 tons per year is being recovered in the form of Russian crude oil deliveries to Austria. Further, the oil industry is under certain strain deriving from obligations towards the Western oil companies, under agreements called "Viennese Memoranda."

In addition, the oil exploitation itself has not been under the auspices of the Austrian territorial right for more than 17 years—from 1938 to 1955—but was for that time exposed to other interests which had as a main object that of achieving as high as possible a yield. Consequently, the Federal Republic of Austria had to note a loss of approximately 24.5 million tons of crude oil. Also, in order to further improve the position of the Austrian oil industry, it was necessary to provide for a better development and investment basis. Thus, the decrease in the natural gas production which was critical at the time when the oil companies were taken over by the Austrian Authorities, had to be stopped, and a more effective natural gas piping system was started to ensure the most profitable use of natural gas. This piping system now has a length of approximately 600 km and is still being continued so that shortly 1.3 billion (Am.) Nm^3 of natural gas will be available to Austrian industry. Also, a new activity was started to discover new oil fields by signing contracts which alleviated the finding and utilization of such fields. The ground where oil might be found and which was sold under contract, covers an area of approximately 12,570 km^2. Finally, the erection of a modern large refinery with a capacity of 2.5 million tons of crude oil per annum was initiated, and this refinery will one day replace the existing old refineries. An up to date petro-chemical plant will complete this refinery program.

It can be considered as a good proof of the efficiency of the Austrian mineral oil industry that Austria has been able to overcome the difficulties of supplying the home oil market, during the Hungarian and Egyptian crises, practically without assistance from outside sources. Austrian oil consumption can now be covered by its own production.

As a country which, compared with its extension and population, has considerable crude oil production, Austria not only has the possibility but also the obligation to ensure the full utilization of these treasures of the earth by procuring the necessary facilities for the geological, mining and technical development, thereby adding an indirect share to the combined European requirements on this sector.

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FOREWORD FOR AUSTRIA

by Section Chief, Dr. H. Kern, Head of the Supreme Government Mining Authority

The Austrian petroleum industry welcomes the request for a number of its technicians to express themselves in an international forum provided by a special number of WORLD PETROLEUM, in order to enable a large circle of readers to obtain a view of the extent and importance of this branch of industry in Austria.

After the withdrawal of the occupation troops and the return of the previously Soviet operated petroleum industry to Austrian hands in 1955, this country may be said to have become an important European oil country overnight, and one which will be free, in collaboration with the petroleum industries of other lands, to build up and expand its own petroleum industry.

To give a sketch of this development is the object of the following contributions by leading Austrian experts in the various fields, as, for example, basic geologic investigation, the production of petroleum and natural gas, the methods of their production, the training of operating personnel, etc.

Along with the reactivation of an independent Austrian petroleum industry, the purpose has been to develop affiliated industries in such a way that they would successfully meet the modern demands that in future, would be made upon it.

It is without doubt that such aims can only be materialized in close cooperation and in peaceful competition with other petroleum producing countries. It is only thus that Austria will maintain its place in the world's petroleum economy and command the respect of others, due to the thoroughness of its development and to its production which for 1958 nearly reached the 3 million ton mark.

HISTORY OF PETROLEUM EXPLORATION IN AUSTRIA

by Professor Dr. H. Küpper, Director of the Geological Survey of Austria

Up to 1918 the territory of the Republic of Austria belonged to the great Austro-Hungarian Empire, which held an important position in Europe by reason of its oil fields of the Carpathian foreland, Galicia, Boryslav, etc. The geologist, G. A. Koch, in 1878 had visited the oil fields of Pennsylvania and later became professor of geology in Prague and Vienna. At the end of the century A. V. Hofer of Leoben had become one of the founders of petroleum science. Already prospectors had found small productive fields: natural gas near Wels in 1891, heavy oil near Taufkirchen in 1906, and asphaltic oil near Egbell in 1914. The last locality is situated close to the present Austrian border and within the productive region, which we now call the Vienna Basin. A major step was taken when the geologists, H. Vetters of Vienna and H. Von Beockh of Budapest put forth the idea that, as suggested by the Egbell discovery, the Vienna Basin might offer opportunities for modern petroleum exploration. In 1920 this thought was translated into action and was pursued through difficulties to successful production near Zistusdorf (Goesting) in 1934. From then on to the present time K. Friedl was the moving force in all further developments. After the first success in 1934, quite a number of new fields were developed viz. twelve small and medium fields in the Vienna Basin which in 1944 produced 1.2 million tons of oil.

After the interruption caused by the war and immediate postwar conditions, exploration for oil took two directions; on the one side exploration and exploitation was continued in the Vienna basin, which since 1945 has been controlled by the S.M.V.; on the other side, since 1952, exploration started in the western Molasse zone and in the Graz basin; in both regions modern geophysical and geological research is being pursued until today. Noteworthy success was met with in the Vienna basin; in 1949 the Matzen field was discovered here and soon became one of the greatest oil fields in Europe, allowing Austria's production to rise in 1954 to 3.4 million tons. In 1956, in the Alpine foreland (Molasse zone, Western Austria) a wildcat well at Puchkirchen was brought into production, and together with previous indications, thus contributed to the prospects of this region as a new oil province.

Finally, the Austrian State Treaty of 1955 arranged for handing over the Soviet governed fields to Austrian government companies, which clarified the legal situation so that from 1957 on, work could begin in the Eastern Molasse Zone, to which is linking up geologically the Bavarian-West Austrian Alpine foreland with the productive Carpathian foreland.

Thus, for the first time in the history of oil exploration in Austria, it became possible from 1955 on, to carry out simultaneously in all geological formations and areas, that in any way could be regarded as oil-prospective, the most modern means of geological and geophysical exploration, including deep drilling.

ÖSTERREICHISCHE MINERALÖL VERWALTUNG

AUSTRIAN MINERAL OIL ADMINISTRATION

THE Österreichische Mineralölverwaltung A.G. (abbrev. OeMV-AG) is the main producer of crude oil (95%) and natural gas (99%) in Austria and during 1957, 68% of the total Austrian oil consumption was refined in its refineries. The OeMV-AG is managed according to commercial principles: the entirety of shares was taken over by the Austrian State.

The OeMV-AG is still a young enterprise, despite the fact that the oil industry in Austria may boast of an old tradition. A retrospective glance to the time of the former Austro-Hungarian Monarchy reveals that 100 years ago, crude oil was struck in the province of Galicia, with consequent establishment of an oil industry, administered mostly from the capital of Vienna.

Oil Production in Austria in 1958

Field	Ownership	1958	Cumulative Production December 31, 1958
		Oil Production in Metric Tons	
Muhlberg	OeMV	187,818	4,017,775
Alt Lichtenwarth	OeMV	603	6,544
Von Sickle-Plattwald	van Sickle	28,340	1,216,072
St. Ulrich-Hauskirchen	OeMV	95,495	4,042,580
Neusiedl	OeMV	155	26,886
Kreuzfeld-Pionier	OeMV and Erdolproduktions GmbH	1,020	19,752
Maustrenk	OeMV	4,566	228,931
Gosting	OeMV and Erdolproduktions GmbH	31,509	1,714,208
Rag	RAG	20,452	792,569
Gaiselberg	RAG	90,553	2,705,489
Windisch Baumgarten	OeMV	—	588
Scharfeneck	OeMV	—	3,576
Hohenruppersdorf	OeMV	592	18,208
Rabensburg	OeMV	1,656	3,498
Matzen Auersthal	OeMV	2,306,095	18,917,300
Prinzwarth	OeMV	1,540	1,681
Aderklaa	OeMV	50,525	1,556,618
Kagran Sussenbrunn	OeMV	10,599	39,001
Pichkirchen	RAG	4,297	11,470
Wegscheid	RAG	160	160
Steindlberg	RAG	451	451
	Total	2,836,396	35,323,357

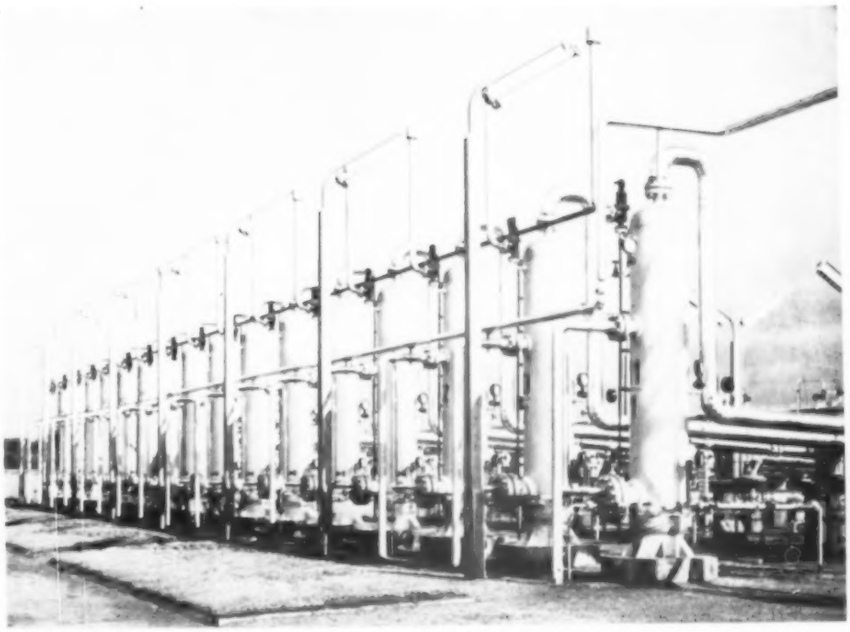
A modern and economic dehydration system with installations serving some 30 wells has been constructed in the oil fields of OeMV-AG.

With regard to the present territory of Austria, it is to be said that the first crude oil in the Vienna Basin was found in 1930 and that the first profitable well dates back to 1934.

The years up to 1938 were devoted mostly to developing a self-sustained industry and this evolution was considerably assisted by foreign capital. At the time of the occupation of Austria by Hitler-Germany, German interests became dominant, but at the end of World War II and as a result of the Potsdam Agreement between the Allies, this property had to be handed over to the USSR. It was not until August 1955 that, on the basis of the Austrian State Treaty, all producing wells and refineries were taken over by the State. However, in exchange for this "switch-over," Austria had to concede to the USSR a reparation of 10 millions tons of crude, to be delivered in shipments of 1 million tons per year. During 1958, an agreement stipulates a reduction of deliveries in such a way that Austria receives (starting 1959) 500,000 tons of Soviet oil free of charge until 1965.

The major part of the properties thus transferred were combined in one enterprise, i.e. the Osterreichische Mineralölverwaltung Aktiengesellschaft (Austrian Mineral Oil Administration), with headquarters at Vienna, IX. Otto Wagner Platz 5. The present centers of production of the OeMV-AG and their production rate is as follows:

In the midst of the Zwerndorf gas field, next to the Czech border, OeMV-AG erected a modern gas distribution plant including installations for gas cleaning, drying, pressure reducing with fully automatic pressure control.



Oil fields	*1957 production metric tons*
Aderklaa	70,664
Auersthal	943,571
Matzen	1,642,775
Mühlberg	243,906
Neusiedl	106,409
Total:	3,007,325

A continuously expanding pipeline network promotes the production of natural gas which amounted in 1957 to:

1957 Natural Gas Production

	normal cu-mt.
Oil Gas	
Aderklaa	10,235,300
Auersthal	93,687,600
Matzen	276,641,100
Mühlberg	39,666,100
Neusiedl	11,652,190
	431,882,290
Dry Gas	
Matzen	93,222,300
Mühlberg	36,198,700
Fischamend	16,498,200
Zwerndorf	157,994,400
	313,913,600
Total:	745,785,890 cu.mt.

The throughput capacity of the OeMV-AG refineries is as follows:

	Thruput-capacity (tons year)
Schwechat	700,000
Lobau (in lease)	400,000
Moosbierbaum	360,000
Korneuburg	350,000
Total:	1,810,000

The first stage of the new Schwechat refinery—under construction—is planned to yield 1,600,000 t/yr. On the other hand, the Lobau refinery—belonging to a Shell Vacuum group—was returned to its former owners under terms of the "Wiener Memorandum," however, an additional agreement permits its further operation for OeMV-AG on a lease basis.

Following the handing over of formerly Soviet administered oil plants and installations to the OeMV-AG, serious problems had to be dealt with. Operations had to be reorganized as quickly as possible in order to comply with Austrian laws and regulations. Several examples will illustrate the requirements of this time: For economy of operation and in view of relieving agricultural production, it was imperative to provide an extensive and modern network of roads and to replace the then common caterpillars with some 600 modern trucks. Obsolete derricks had to be replaced by new, truck-mounted hoists with telescopic masts.

Special attention had to be given to natural gas economy, as—until 1955—about 44% of the gas produced could not be utilized. The completion of an expanding network of pipelines, equipped with modern compressors, as well as gas drying installations and the setting-up of pressure-reducing and degasing stations allowed the reduction of losses to negligible amounts. It may be stated that such modernization and rationalization was also extended to quite a number of other sections.

Some 20 rigs (drilling capacity up to 700 m month) are operating for exploratory purposes, combined with 6 geophysical crews.

Further modernization of plant equipment was also extended to the production section, by providing a satisfactory

The oil fields of OeMV-AG reach the suburbs of Vienna.

The new built OeMV Central Compressor Station at Auersthal has a total throughput capacity of 1 Million cubic meters per day of natural gas. Natural gas is compressed here for transportation to the customers.

and economic dewatering system, each single installation serving some 30 wells. Production methods were improved and intermittent gaslift methods were adopted to increase efficiency.

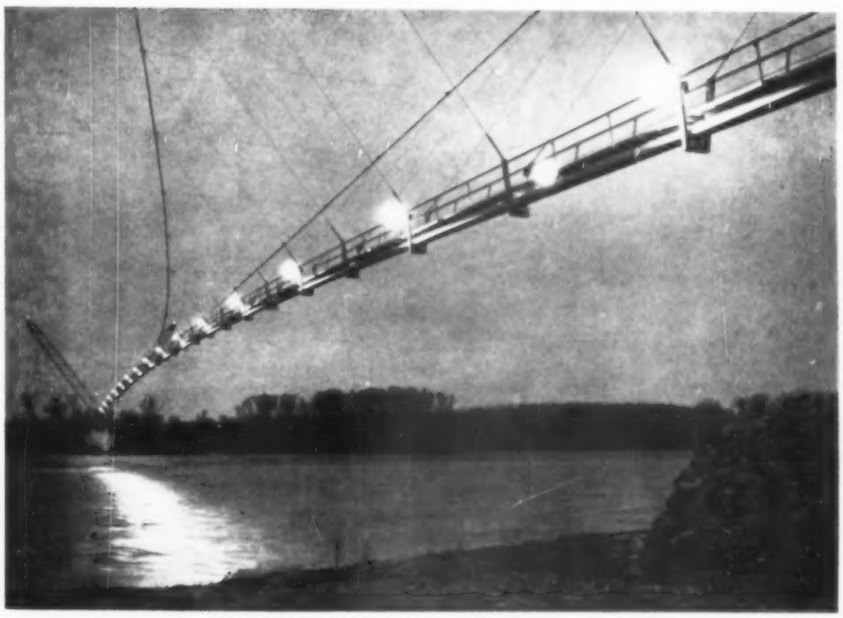
Exploration in new concession areas is conducted by employing modern methods of seismic, gravimetric, magnetic, radiometric, and telluric analysis.

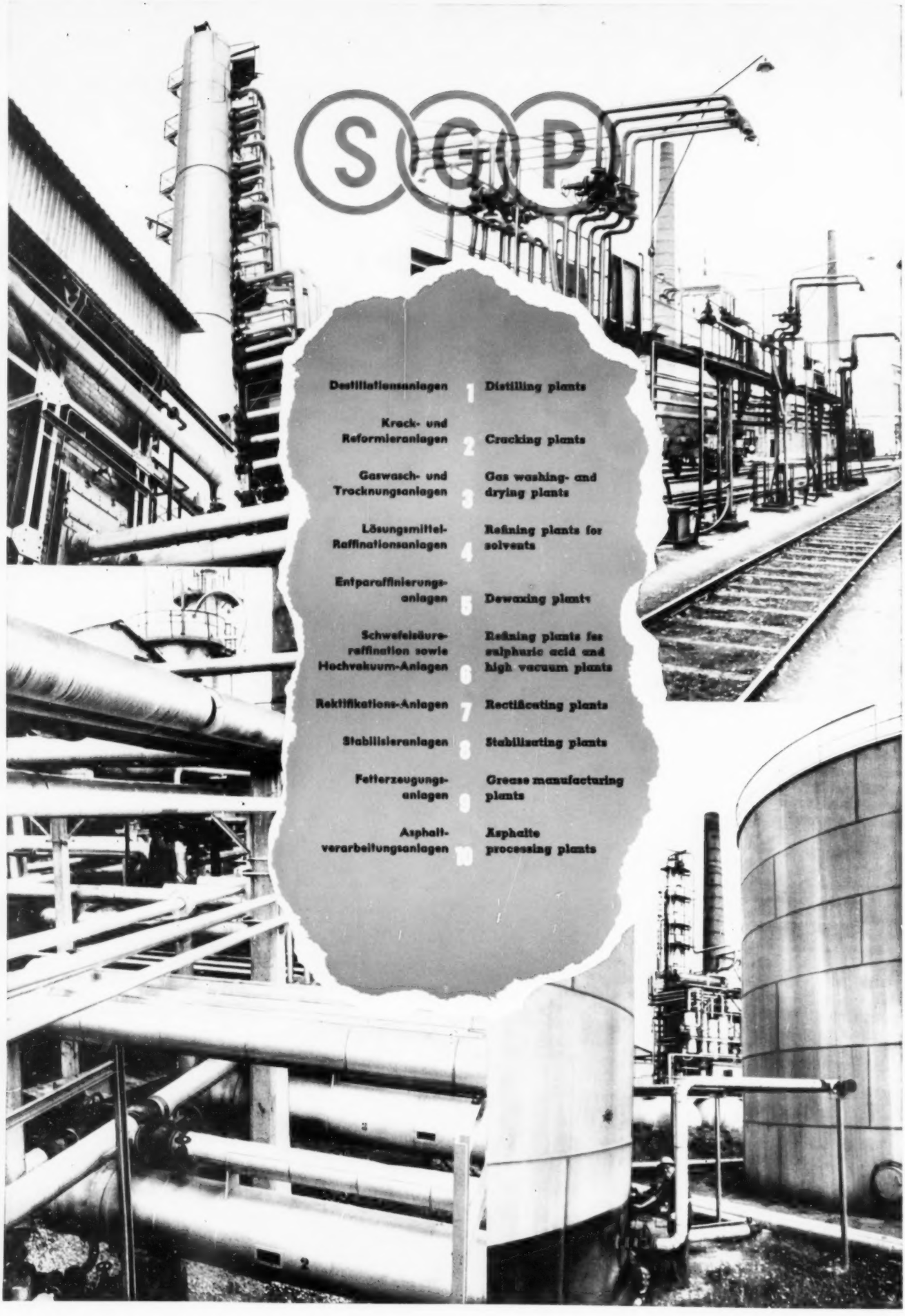
It remains to state that one of the biggest (although not yet completed) problems for the OeMV-AG is the erection of a new refinery at Schwechat. A stagewise construction is planned. The first step was started in April 1958 and provides for a refinery having a capacity of 1.6 million tons per year; the second step foresees an additional increase by 900,000 tons. In view of continuously increasing market demands, especially for high grade oil products, the construction of a modern refinery installation is a pressing necessity.

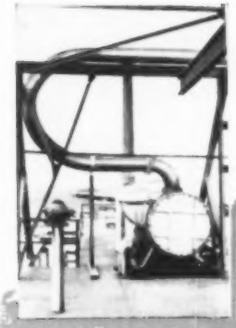
Friendly relations are maintained with a number of internationally renowned oil enterprises, warranting a continuous exchange of practical and scientific experiences. For example, there exists a contract of association with the British Petroleum Co. Ltd. for the exploitation of joint areas.

Finally, it may be mentioned that all endeavors are made to enlarge the staff of experienced engineers and scientists. The cooperation of a number of consulting scientists from home and abroad was secured, in order to provide expert advice in case of necessity.

The natural gas line over the Danube, the so-called St. Barbara's Bridge, built by the OeMV-AG is one of the most magnificent examples of construction of its kind.




S G P
Destillationsanlagen 1 Distilling plants
Krack- und Reformieranlagen 2 Cracking plants
Gaswasch- und Trocknungsanlagen 3 Gas washing- and drying plants
Lösungsmittel-Raffinationsanlagen 4 Refining plants for solvents
Entparaffinierungs-anlagen 5 Dewaxing plants
Schwefelsäure-raffination sowie Hochvakuum-Anlagen 6 Refining plants for sulphuric acid and high vacuum plants
Rektifikations-Anlagen 7 Rectificating plants
Stabilisieranlagen 8 Stabilizating plants
Fetterzeugungs-anlagen 9 Grease manufacturing plants
Asphalt-verarbeitungsanlagen 10 Asphalte processing plants

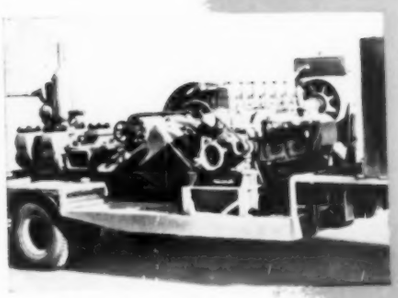


FERNER:

Destillationskolonnen	Entspannungstürme
Glockenböden	Druckbehälter
Stripper	Neutralisiergefäße
Röhrenöfen	Polymerisationstürme
Wärmeaustauscher	Filter
Kondensatoren	Agitatoren
Teerabscheider	Behälter (Kegeldach und Schwimmdach)
Gasabscheider	Rohrleitungen
Reaktoren	

FURTHER:

Fractionating columns
Bubble trays
Strippers
Tube furnaces
Heat exchangers
Condensers
Tar separators
Vapor separators
Reactors
Flash towers
Pressure tanks
Acid knock-out drums
Cat poly reactors
Screens
Agitators
Tanks (with cone roof or with floating roof)
Pipings



SIMMERING - GRAZ - PAUKER

A. G. FÜR MASCHINEN-, KESSEL-U. WAGGONBAU

WIEN-AUSTRIA

OIL-GEOLOGICAL CONDITIONS IN AUSTRIA

by Dr. R. Grill, Chief Geologist, Geological Survey of Austria

General Geological Units of Austria

Bohemian Massif, Alps, and Tertiary basins are the general units controlling the geology of Austria. Of these, the Tertiary basins are in the focus of oil-geological interest, and from them stems the entire oil production of Austria. As compared with those basins, the Alps—to the extent they are made up of thicker sediments at all—due to their intense tectonics are presently less interesting from an oil-geological viewpoint. Within the Austrian part of the Variscian horst of the Bohemian Massif, where crystalline schists and eruptive rocks entirely take the place of sediments, there are probably no prospects whatever of finding oil or gas reservoirs.

Molasse zone, Inner Alpine Vienna basin, and Graz Basin are the three most important Tertiary basins in Austria, to which there are added a number of smaller marine depressions such as the Korneuburg Basin, the Lavant valley, etc. In respect of origin, the North Alpine Molasse zone is older than the Vienna and Graz basins. It is chiefly made up of younger Paleogene and Neogene beds which had been deposited, in a thickness of maximum about 4,000 meters in a geologically young ocean trough, in front of the rising Alpine arc thrusting toward the north. The Alpine-Carpathian foreland between St. Pölten and South Moravia is also called "Outer Alpine Vienna basin."

The Inner Alpine Vienna Basin is a large subsidence basin within the Alpine-Carpathian arc, situated within the bend where the Alpine WE direction turns to the Carpathian SW-NE direction. Beginning with the Middle Miocene, when the Molasse sea started receding in wide areas, until Lower Pliocene, the Vienna basin subsided at big synsedimentary fault lines, and in the changing seas there was deposited up to a 5,000-meter-thick complex of strata, consisting of marine (Helvetian and Tortonian), brackish (Sarmatian), and brackish-limnic (Pannonian) sediments. Even in geologically recent time, in young Pleistocene, considerable subsidences with vertical throws of up to more than 100 meters can be ascertained in separate closely delimited zones of the basin, and a not inconsiderable seismic activity is tied to those zones of young tectonic movements.

The Graz basin at the eastern margin of the Alps subsided at approximately the same time as the Inner Alpine Vienna basin, and there is found a sequence of strata several thousand meters thick which resembles the above one in many respects. (Fig. 2.)

Flysch and Molasse Zone. Of the various Alpine zones differing by composition and structure, only the northernmost and youngest one, viz., the Flysch zone, is presently of oil-geological interest. An essential factor in judging the oil prospects of that zone is the circumstance that the several thousand-meter-thick Flysch sediments proper, marine marls, sandstones, and shales of the Cretaceous and Paleogene were proved in many places to rest on an overthrust floor of Cretaceous and Paleogene limestones rich in fossils, marls, and shales as well as other rocks of the *Helvetic* which originally had been deposited in an ocean trough north of the Flysch zone. Finally, those overthrusts to the north affected also the more southern trough parts of the Molasse; and, in the *window* of *Rogatsboden* in the Lower Austrian Flysch zone, Lower and Middle Oligocene Molasse members crop out under overthrust Helvetic and Flysch. Thus, a double window is proved there.

The Flysch zone, in turn, was overthrust by the northern Limestone Alps, and most recent mapping work has proved a Flysch window within the Limestone Alps at *Brettl*, south of Rogatsboden. Even farther to the south lies the window of *Urmannsau*, which was explored some time ago and where—within the structure of the Limestone Alps—deeper overthrust nappe elements crop out under higher ones. A natural oil outcrop which has been known for centuries is tied to that window, and scant oil shows have been observed also at the window of Rogatsboden.

Flysch windows within the Limestone Alps have been known also farther on to the west, in the Upper Austrian part of the Limestone Alps, in the areas of *Windischgarsten* and *Grünau*. Accordingly, after more modern mapping in the Flysch zone becomes available, it may prove worthwhile in the more distant future to investigate in greater detail also certain parts of the Limestone Alps, although those areas seem to be less prospective by reason of their extraordinarily complicated structural conditions (see cross-section, Fig. 3).

Viewing Galician oil fields, it is not surprising that in former times much oil-geological speculation centered on the Flysch zone and its foreland, whereas any

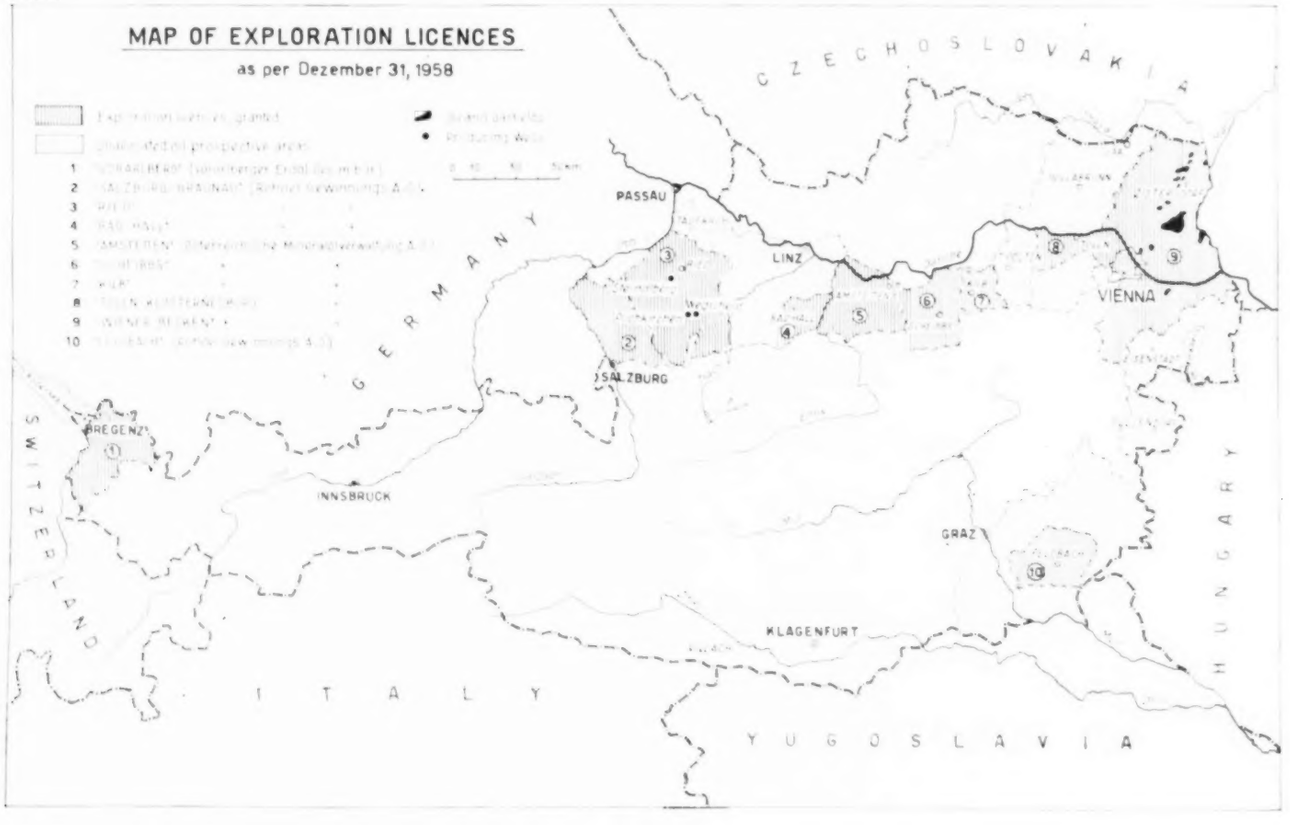


Fig. 1.

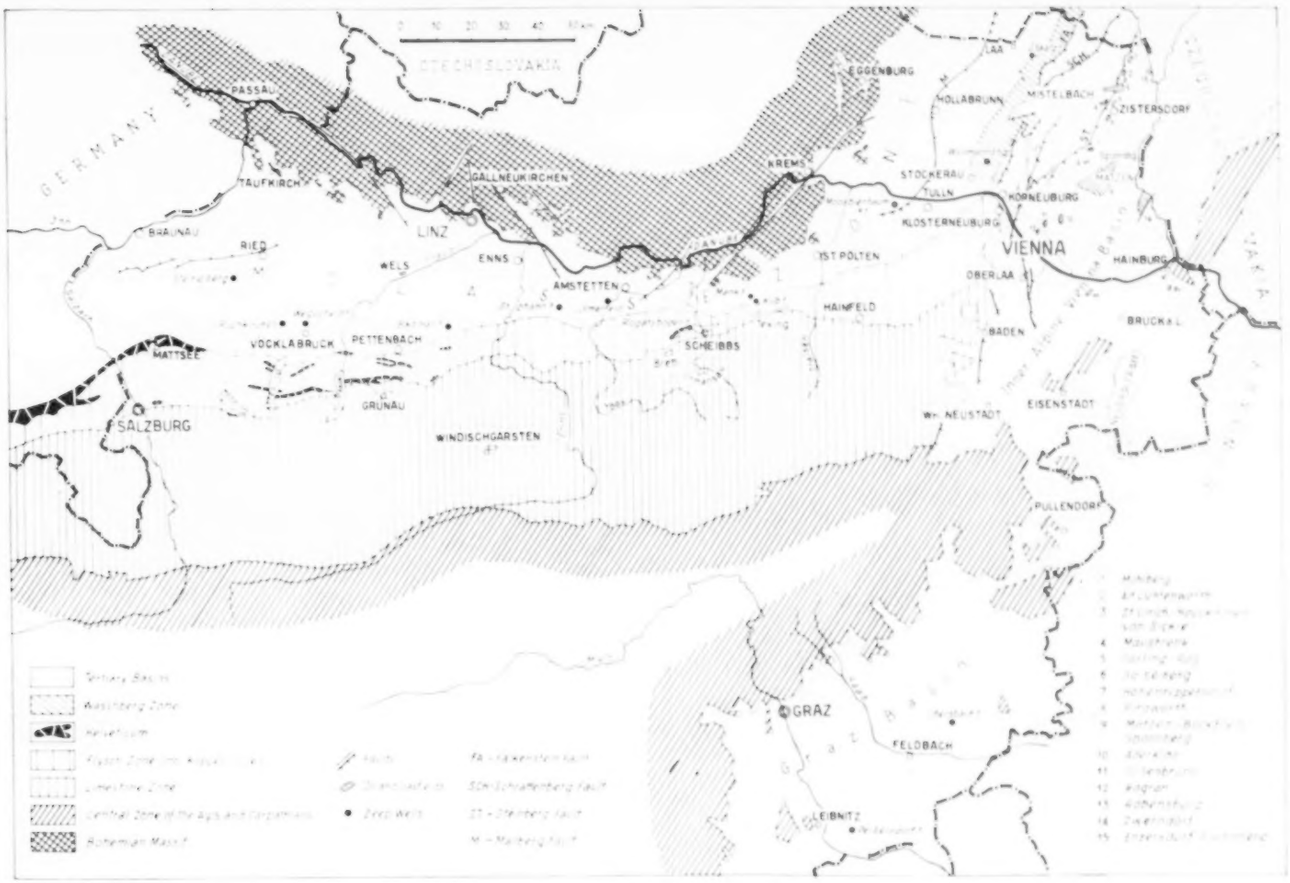


Fig. 2. Geological sketch of the oil producing areas in Austria.

exploration activities in the Inner Alpine Vienna Basin could not then be thought of. Particularly in the Alpine foreland, small reservoirs had been discovered a long time ago, and this furnished proof that oil and gas could form in the deposits of the Molasse.

Exploration of the small, now largely depleted gas field of *Wels* dates back to 1891. Dry gas encountered here at an average depth of 200 to 300 meters was found in very thin, lenticular sand intercalations in the younger, Burdigalian Molasse part (Miocene schlier). The *Leoprechting* heavy-oil reservoir, situated at the northern margin of the Molasse at a depth of 120 to 140 meters, was discovered in 1906, but it was only in 1946-1952 that the highly viscous oil was produced more or less continuously, viz., by heating the reservoir through steam injection or by running in electric heaters. However, production was again abandoned as uncommercial. During the period, a total of 4,311 tons of crude oil had been produced from 124 wells.

It had long been clear that the Leoprechting oil must have migrated from the depth of the basin. Formation of the small reservoir near the basin rim is due to a combination of erosional underground relief and a fault striking in Saxonian direction, as is evident from more recent exploration results.

The idea suggested itself that reservoirs containing a lighter oil might be searched for in the interior of the basin; however, decades were to pass before the first reservoir was discovered in the deeper part of the foreland, viz., at a time when the present peak production had already been reached in the Vienna Basin. It was only by means of reflection seismic surveys that the structural conditions decisive for the oil accumulation in the interior of the basin were recognized; in a deeper tectonic section, numerous indications for traps were found which are not depicted in any way in the upper, Miocene, transgressing members. The oil occurrences of Puchkirchen (1956), Wegscheid (1958), and Steindlberg (1958) were thus discovered, at depths below 2,000 meters, or slightly above. In the course of those explorations, the well Perwang 1 was drilled to 3,528.8 meters; this is Austria's deepest well at present. The future will show whether the higher Molasse section, too, contains reservoirs of exploitable thickness. Perhaps stratigraphic traps will have to be assumed there, which have so far escaped close control. This actually is indicated by the Wels gases whose source rocks can be the Miocene schlier only where—as already mentioned above—they occur in sand lenses which often are only centimeters thick. Another remarkable feature is that, at the sandy base of the Burdigalian part of the Molasse section, gas shows and salt water were encountered also at other points of the Upper Austrian foreland, which seems to prove that those horizons are sealed off towards the basin rim by local marly zones.

West of the Salzach River, Flysch and Molasse lie outside Austrian territory, and it is only in *Vorarlberg* that parts thereof again lie in Austria (see Fig. 1). In that area, in the wide Rhine valley, reflection seismic surveys have been carried out for the Vorarlberger Erdölgesellschaft mbH, on the Molasse which is buried under Pleistocene and Holocene deposits and which, on both sides of the plain, forms elevations of alpine character. There, the Molasse is strongly folded near the Flysch.

In line with the small width of the Molasse trough between the Enns and Traisen Rivers in Lower Austria, also the depth of the basin is considerably smaller these than in the wider Upper Austrian foreland part and its continuation to southern Germany. Accordingly, a number of deep wells drilled in the Lower Ausrtian part reached the crystalline basement above 1,000 meters—among them the Mank 1 well (top Crystalline 747.2 meters, final depth 790 meters) drilled by Oesterreichische Mineralölverwaltung AG in 1958. In the neighboring wells of Kilb, drilled in 1944 and 1947, oil shows with salt water had been encountered at the Molasse basis, whereas some other wells (Ulmerfeld 1 and St. Johann 1 west of Amstetten) encountered only fresh water.

Middle and Lower Oligocene, as well as Upper Eocene, from which the Upper Austrian-Bavarian oil and gas reservoirs mainly derive, have so far not been encountered in the wells drilled to the Crystalline in the area between the Enns and Traisen Rivers. There, the southern parts of the Molasse are completely overthrust by the Alps, thrusting towards the southern spur of the Bohemian Massif; and a pre-

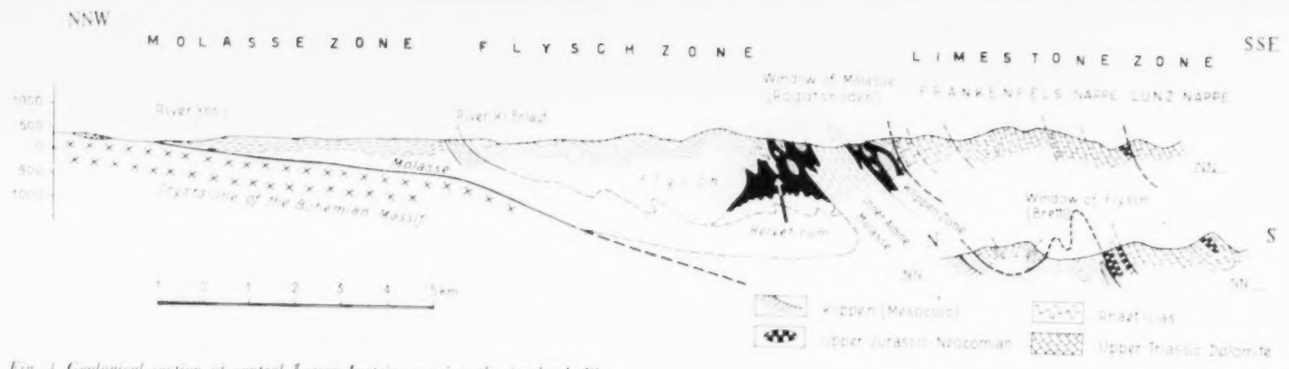


Fig. 3. Geological section of central Lower Austria covering the foreland, Flyschzone and northern part of the Limestone-Alps. By S. Prey and A. Ruttner.

liminary survey seems possible only in the several imbricated windows within the Flysch zone. Future deep drilling will first have to be restricted to the zone of those outcrops. Owing to their shallow depths, the wells so far drilled yielded but scant information on the overthrusted Molasse. Rogatsboden 1, drilled in 1936-1938, reached a final depth of 461.10 meters, and encountered Inner-Alpine Molasse, varicolored marl series (Helvetic) and Flysch in repeated imbrication, just as the well Rogatsboden 1-a drilled in 1939-40, whose final depth was 315 meters. The study by S. Prey makes it probable that a large lenticular imbrication is involved which, in addition, is presumably dissected also by steep faults. Early in 1959, the OemV commenced drilling a deep test, Texingl, situated in a tectonical window similar to that, and situated east of Rogatsboden.

In the wider Outer Alpine Vienna Basin, geological conditions similar to those in the Upper Austrian part of the foreland may well have to be expected, in places. It is to be hoped that the deep well Staatz 1 of the Oesterreichische Mineralolverwaltung AG will yield essential data for that part of the basin which has so far been little explored by deep wells.

Waschberg Zone. The said well Staatz 1 is connected with structures within the area of the overthrust of the Waschberg zone over the Molasse. The Waschberg zone begins in the Stockerau area, north of Vienna, and continues on the northeast in the formerly so-called sub-Beskidian nappe on the outside margin of the Carpathians. Westward, a tectonic connection with the subalpine Molasse east of St. Polten seems probable.

Fig. 4. Stratigraphic range of the oil producing and oil prospective areas in Austria.

Wtihin Austria, the Waschberg zone is chiefly made up of marine shales (Auspitz marls) of considerable thickness, which—at least partly—are assigned to the Miocene. Imbricated with those shales are parts of Upper Jurassic limestone, Cretaceous deposits of different facies, as well as Eocene (Fig. 4); the entire complex of thrust slices plunges under the Flysch in a southeasterly direction. Accordingly, structure conditions are not simple. However, even the thick marine marls make the zone appear to be not uninteresting from an oil-geological viewpoint. Up to now, that zone has been tested only by few deep wells, of which the well Wollmannsberg NE of Stockerau, drilled in 1922, made headlines by some minor gas blowouts. However, a productive reservoir was not encountered.

Inner Alpine Vienna Basin and Graz Basin. It was assumed a long time ago that the Inner Alpine Vienna basin is bounded by big marginal faults, and a distinction was made, i.e., between a western and an eastern thermal line along the borders of the southern part of the basin. However, it was only in the '20's that K. Friedl found considerably bigger faults of vertical displacement up to 2,000 meters extending through the interior of the basin. The discovery of most of the oil and gas fields here is due to the fact of a tectonically continuous evolution of that basin. Comparatively shallow Upper Middle Pannonian marker horizons, which were tapped by structural wells, yielded preliminary information as to the structural conditions at depth. All fields on the downthrown block along the Steinberg fault were discovered in this way. The first of these fields was the Gösting field by which K. Friedl in 1934 developed the first commercial oil reservoir in Austria. Apart from negligible quantities from the foremost Pannonian, the production of the fields on the downthrown block comes from the Sarmatian and Tortonian. In that area, the underlying Helvetian schlier has not yet been tapped anywhere, and thus those old fields still offer some prospects, but at greater depths, however.

Whereas the fields on the downthrown block are connected with drag structures of the Steinberg fault, the development of the middle field of St. Ulrich-Hauskirchen (1938) on the upthrown block west of the Steinberg fault depended on the buried basement relief. In that field, the oil was found either in the Flysch or in sandy layers of the overlying schlier. After the success achieved in St. Ulrich, the entire upthrown block between the Steinberg fault and the Schrattenberg fault west thereof was tested for reservoirs of a similar type, but it was only possible to discover some minor fields in the closer environs of the St. Ulrich-Hauskirchen field.

The years after 1945 were marked by exploration in the central parts of the Vienna Basin, which in separate zones had started even earlier. The fields of Matzen and Zwerndorf were discovered; the oil-bearing part of Aderklaa was developed; and there are indications for further success at Spannberg, Rabensburg, and Pyrawarth.

As mentioned previously, most of the oil fields in the Vienna Basin, so far as their production comes from the Sarmatian or Tortonian, were discovered by structure drilling for shallow marker horizons. In the fields on the upthrown block, this prospecting method proved to be less successful and, particularly there, geophysics were a most valuable help even before 1945. With the further development of the downthrown block east of the Steinberg fault, any progress in that area without geophysics has seemed unthinkable for some time past. The Helvetian beds of the basin are unconformably overlain by Tortonian, and a systematic exploration of reservoirs in the deeper tectonic section is possible only by means of mapping the deeper underground. Accordingly, in the Vienna Basin, too, intense geophysical activity is going on, especially reflection seismic surveys. After the comparatively easy discoveries by conventional methods of the reservoirs in the higher tectonic levels, we shall now have to find new reservoirs at greater depth, where traps might be tied to an older tectonic cycle.

In the Graz Basin, a success has not yet been achieved. However, it should be borne in mind that up to now only a few deep tests were drilled, and that there is still a sufficient number of oil-geological possibilities in that basin. The well Uebersbach 1 of RohoelGewinnungs AG, which recently was completed with some oil shows, is located on a broad basis of reflection work. Essential questions which, in part, are still unsolved here concern the facies of the Helvetian and Tortonian in the deeper part of the basin, and the tectonics of the deeper underground. Up to now, big tectonics have not been encountered in the Graz Basin proper, west of the South Burgenland swell, and it seems that structural conditions might chiefly depend here on the basement relief.

MAGNESIT in the petroleum and natural gas industries

The material Magnesit which has entered a wide field of application because of its excellent heat resistance and its resistance towards chemical agents at high temperatures, has not yet been employed much in the oil industry. Wherever high temperatures are obtained by heating either fuel oil or natural gas, the importance of the Magnesit and the chrome-Magnesit stones in all their modern variability (e.g. combined with chemicals or in steel sheet casing, as so-called Steelklad-Stones) is more and more being realized. For instance, Magnesit is preferred as material for Siemens-Martin furnaces in the steel industry which are being fired with fuel oil or natural gas, or for rotary kilns and shaft furnaces in the cement, lime and dolomite industries. Also in small furnace units of the industry processing copper-bearing metals, or in firing units for central heaters burning fuel oil, darting flames are frequently noticed and the temperature increase is so high that the normal heat resisting material does not guarantee a long durability. It is here, however, where Magnesit products with their thermal fluctuation resistance have kept operating costs low and have achieved good economic results.

In order to desulfurize the flue gas of fuel oils in steam boilers, and consequently, to prevent corrosion within the dew point range (which lies at 140-150° C!), Magnesit products are employed with good results.

In the petroleum and natural gas industries, Magnesit is mainly used as catalyst carrier in the cracking of natural gas or of liquid and gaseous mineral oil products into city gas or synthesis gas. It is known that this process of cracking methane, propane and butane into a gas with a high hydrogen content and thus, with a high initial velocity, is carried through with the help of super-dispersed metallic nickel as a catalyst, at temperatures of normally 600-800° C. In these large scale operations, temperatures up to and over 1200° C can be measured, and it is therefore of some importance to find a catalyst carrier for the nickel which shows a high heat resistance and great chemical inertia. As such, Magnesit has, of all other material, proved its utility even beyond the temperature limit obtained in this process.

It is a further advantage that nickel does not react chemically on burnt Magnesit. Thus, a formation of nickel-spinell ($NiAl_2O_4$) will not happen which, at the use of other catalyst carriers, causes a quick loss of catalyst activity.

For many years, Badische Anilin- & Soda-Fabrik (BASF) has had excellent results with Magnesit as a catalyst carrier in the production of synthesis gas for the nitrogen fertilizer production.

This process was taken over later on by the Linzer Stickstoffwerke in Austria. This catalyst shows practically no loss of activity even when combined with sulfur and hence is considered very valuable.

For the production of city gas from natural gas, Magnesit was used for the first time by the Viennese Gas Works as catalyst carrier a few years ago and, when good results were noted, it was also introduced in large units. In the Viennese Gas Works, catalysts on a Magnesit base have been in use for $5\frac{1}{2}$ years, and there is still no need for replacement.

To date, the Magnesit has been used for the above purposes in the form which was originally given to the material in Magnesit production units. It is obvious that in this form it could not meet the special wishes of the manufacturers and consumers of nickel catalysts, in spite of the excellent basic qualities of Magnesit. This was the reason why the Veitscher Magnesitwerke have built a unit which enables it to produce catalyst carriers in all forms meeting the special requirements of the natural and synthesis gas industry. The new granulated Magnesit has the shape of perfectly round balls and the granulation sizes can be chosen at will, from a 5mm to a 40mm diameter. These grains have a homogenuous character and show a high porosity of approximately 40% through to the center, so that they can absorb also high percentages of nickel.

In spite of their porosity, the Magnesit grains are strongly abrasion-proof and resisting towards all kinds of mechanical strain.

It is a further advantage that granulated Magnesit can be produced with every required ferrous content down to approx. 0,8% Fe_2O_3.

It can be assumed that Magnesit as a catalyst carrier "made to measure", in the form of granulated Magnesit, will in future make more and more friends in the natural, synthesis and refinery gas industries and in cracking units for the petroleum industry.

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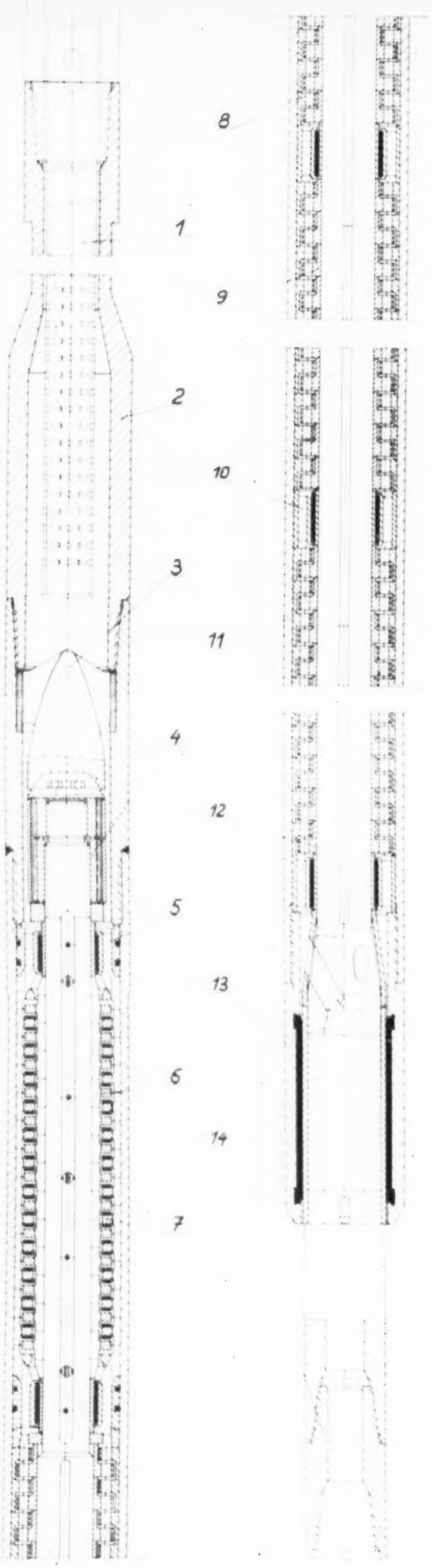
TURBODRILLS

by H. Rietsch, Vienna



The old idea of driving a drilling bit by means of a turbine took a long step toward realization ten years ago when the main problem for successful operation was recognized, namely, the necessity of providing rubber bearings for the turbine shaft. This laid the basis for the development of a new drilling technique that not only allowed more rapid drilling, but held the prospect of drilling to greater depths than is attained by the rotary drilling method.

Turbodrills can operate with a speed of about 600 to 900 rpm without imposing much strain on the drill stem. In case of an overloading, the turbine comes to a stop, which assures that the rotation movement which has to be absorbed by the drill stem cannot be exceeded. Directional drilling becomes simplified and is rapidly carried out. The use of lighter drill pipe is a valuable feature, as is also the protection afforded to the mud discharge and the rotating table. As a disadvantage may be noted the rapid wear of the axial bearings and the turbine blades caused by the high velocity of the drilling fluid.

For many years turbine drills of Russian make have been used in Austria. More recently turbine drills made by Mannesmann-Trauzl in Vienna have come into use. The patented axial bearings of these drills have given substantial satisfaction. Besides drill turbines of $6\frac{5}{8}$" and $8\frac{5}{8}$" outer diameter, Trauzl also furnishes 10-inch turbines. The $7\frac{1}{2}$-inch size is in development, thus providing Austria with a suitable dimensional range of turbine drills.

The constructional scheme for a 98-stage turbine drill is shown in the accompanying drawing. Through the relief arrangement the drilling fluid serves the important axial bearings as a lubricating and cooling medium that passes along their rubber-lined surfaces on its way to the turbine. After its exit therefrom through appropriate passages, it again goes into the shaft and thence to the rotating chisel.

The axial clearance of the rotor and the lead wheels is critical with respect to admissable wear on the load bearings, and at every inspection of the turbine must be carefully measured. The construction of the supporting bearings must not only provide for a small degree of wear, that is, a longer interval between inspections, but must also reduce the degree of friction. The axial bearings thus function as a lamellar brake, and consume the greater part of the moment of rotation of the turbine. The principal consideration for the further development of this drill therefore concerns these bearings. These improvements will be characterized by the fact that their sliding planes will be entirely within the stream of the flushing fluid. Outlying parts of the supporting rings of the bearings are oppositely arranged on the gliding surfaces so as to provide outwardly flowing stream channels, while within the ring-shaped flow surfaces provide passages for interior flowing streams. Above and below the system of support bearings are guide bearings which are constructed so that the flushing stream is divided in passing through the channels and then reunited to pass into the turbine.

In order to keep the clearance between th numerous turbine stages as small as possible, the radial play of the turbine amounts to about 1 mm. This requires an extraordinarily accurate adjustment of the many-faceted tube mantle in regard to tolerance and the straightness of the hole, and puts a limit on the length of the turbine.

If a greater number of stages in the turbine for work in soft formations is required, double turbines have to be provided. Above the normal turbine a second one is placed, which has no axial bearing. The action of its hydraulic thrust on a smooth conoidal coupling binds together both shafts, so that the lower turbine not only absorbs the thrust of the upper one, but also its moment of rotation. The two turbines are transported separately. Their mantle tubes are screwed together at the well site. Sizes under $6\frac{5}{8}$" are built as a triple turbine.

Finally, it maybe interesting to note the action of the axial thrust of the turbine, which varies with the square of the volume of the flushing fluid, and the number of stages of the turbine. This has a great importance in drilling work in that it puts a load on the axial bearings of the turbine, and thus imposes a pulling traction on the lower end of the drilling rod, that disappears when it is counteracted by a drilling pressure of the same magnitude. Therefore, it is possible to load the bit up to the complete value of this thrust—for example, 15 to 20 tons for a 10" turbine—without using heavy rods and without applying more pressure on the rod at the bottom of the hole.

Figure 1. Turbodrill of the Mannesmann-Trauzl A.G. of Vienna (Austrian and foreign patents). 1. Filter for the sample stream, 2. Upper overpass, 3. Relief arrangement, 4. Shaft socket, 5. Upper guide bearing, 6. Run ring, 7. Bearing ring, 8. Lead wheel, 9. Flow wheel, 10. Middle guide bearing, 11. Mantle tube, 12. Shaft, 13. Spann Nipple, 14. Bit overpass.

DRILLING AND PRODUCING TECHNIQUES

by V. Gerzabek, (Production Manager of RAG)
and H. G. Ulrik, (Production Manager of OeMV)

A large part of the prospective oil area in the Vienna and Graz Basins and in the Molasse (the Alpine foreland) has not yet been fully explored, although the largest oil and gas fields in Austria have probably been discovered. These undeveloped regions will in future be explored by individual companies or by two companies jointly in a sort of consortium. For deep drilling operations there are available at present (end of October 1958) 39 drilling rigs of which three units are designed for 1,500 meters, 32 for 2,500 meters, three for 3,500 meters and one for below 3,500 meters.

The greater number of these rigs (80%) are of Austrian make, although only a few of them are of recent design; some are old German or Russian rigs, the rest are of modern American make.

The annual meters drilled by each of these rigs varies between 5,000 to 10,000, depending on the purpose for which the rigs are in use—either purely exploratory or for the development of proven fields.

This capacity is achieved, in spite of a considerable amount of thorough testing jobs of all kind, done especially in each wildcat well, and numerous cases of directional drilling. Nevertheless it will be possible to further increase the yearly capacities because in Austria the trend towards using rigs for drilling only is fostered and all auxiliary work more and more is left to other organizations. Today the individual firms prefer to do the finishing work with their own "completion outfits." If in future exploration drilling the location schedules for a rig can be more accurately forecast, the exploratory rigs can be kept busier and the yearly stints of the rigs considerably increased.

By the use of newer rig equipment in Austria, the most modern and technically up to date methods of operation are being applied. Next to the most frequently used roller bits, diamond bits and crowns have been installed. Great improvements in drilling techniques were achieved also by the use of modern methods in handling the drilling mud. Supervision of the mud is assigned to specially trained mud engineers, who have at hand stationary and mobile laboratories not only for the control of routine work but also for research on the drilling fluid. Former difficulties in mud handling can today be regarded as completely overcome.

Use of drill stem tests in uncased drill holes while passing through interesting strata has saved much time and has allowed earlier completions. Drilling with drill tubing and strings of large dimensioned drill collars has in recent years contributed to an increase in the drilling capacity.

Turbine drilling which was introduced into Austria during the Russian occupation, is now widely in use and partially adapted to local requirements. In Austria this method is chiefly employed in the drilling of deflected holes where it has the advantage of quicker progress and more easy orientation than with other methods for directional drilling.

In the developed oil fields of Austria—the greater number of which are situated in the Vienna Basin—there are about 900 wells in production, of which 200 are flowing, 652 on pump, 22 on gas lift and 26 bailed wells.

The Matzen field, the largest single oil field in Europe, with a present daily output of about 6,110 tons, supplies 82% of the total Austrian production. The rest of the production comes from the Muhlberg, Zistersdorf, Gaiselberg, Aderklaa and Neusiedel fields in Eastern Austria and from the Puchkirchen field in Upper Austria.

The flowing stage of the Matzen wells lasts (depending on the producing horizon) for up to eight years. After this, the wells are usually pumped. Recently, especially in connection with the development of the Zwerndorf natural gas field, some Torton and Helvet horizons of the Matzen field affected by production difficulties are being produced by the gas-lift method which has so far come up to the best expectations. It is thought that in the future this method will come more and more into use.

As in most other countries, oil production in the Austrian fields is beset with various difficulties. Troubles with sand are met partly with silica gel and partly with plastics, and with a newly introduced and patented method which has proved to be effective in many cases. Paraffin trouble is countered by flushing with hot oil, or by the addition of paraffin solvents, by electrical heating of the tubing, by scraping or by a plastic lining (1.5 mm) of cellulose acetubutyrate of the tubing; by the last mentioned method excellent results are obtained.

Much attention is given to premature wear of deep pumps mainly on account of corrosion. Chemical corrosion is countered by use of inhibitors, galvanic corrosion by cathodic protection together with magnesium anodes. The long term results of these experiments is not yet clear and the indications of their success are rather controversial.

It is today evident that reservoir conditions require constant attention. In this field trained personnel and well equipped laboratories have made it possible to maintain optimum producing conditions. The reduction of production in recent years has been not a little due to stronger measures applied to control the reservoir conditions especially by a careful observation of the oil/gas ratio. Well equipped measuring crews are maintaining constant observation of pressures in the formation and the well, and are using all appropriate measuring techniques for this purpose.

Along with the application of secondary producing methods, water flooding has been used for many years with success in the Neusiedl field. A similar but much larger project for the eighth Torton horizon of the Matzen field is in preparation and will probably be put through in 1959. Other smaller projects in other fields are under way.

Since many wells still drilled under the former Russian management are showing deterioration of their cement coating, they require extensive repairs. These often present difficult problems, depending on the character of the formation. In many cases the Halliburton Oil Well Cementing Co., recently established under Austrian law, is being called on to assist in solving these problems by means of the most up to date methods.

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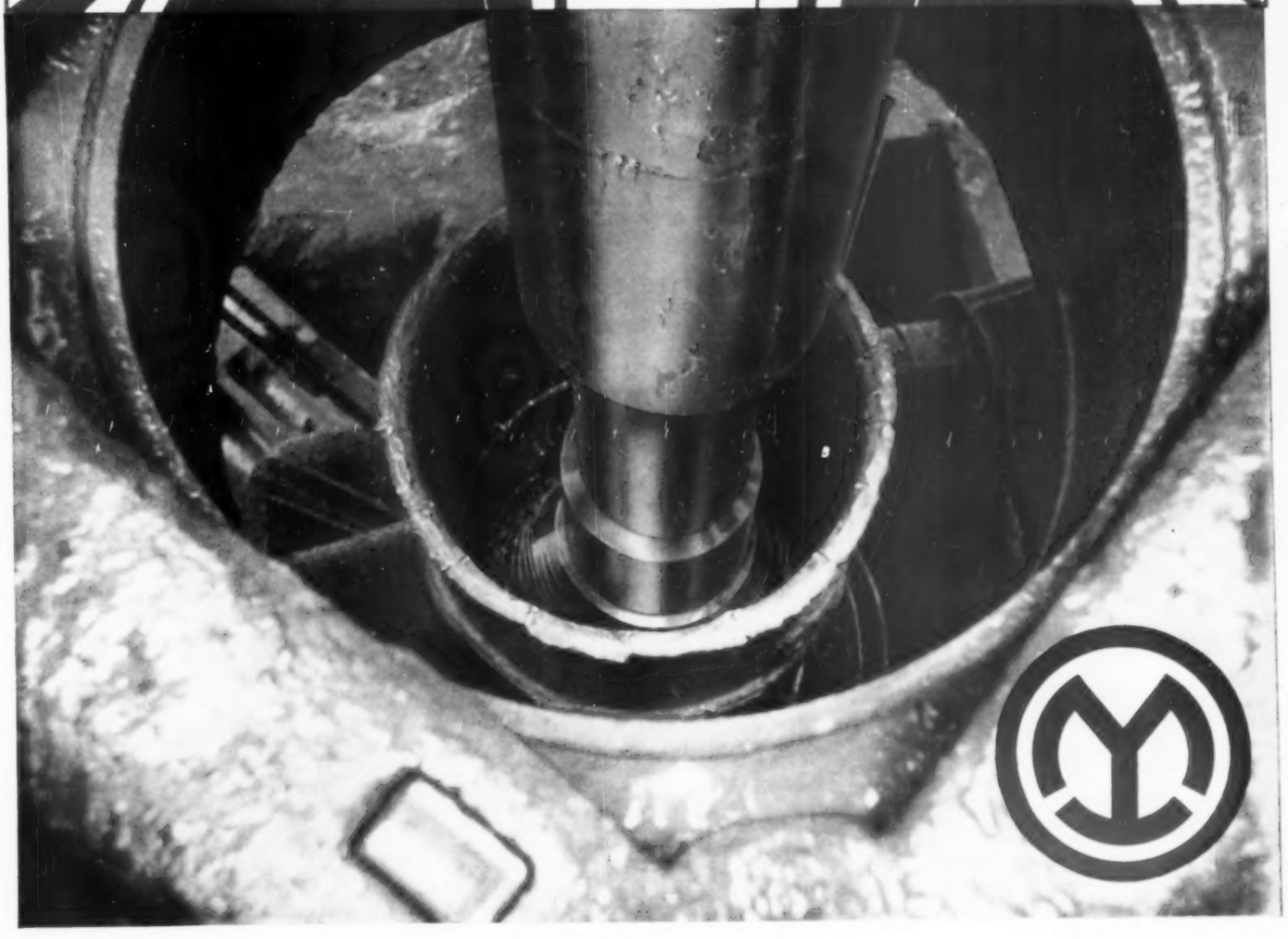


THE GRAZ BASIN

by Dr. R. Janoschek, Exploration Manager of Roh-Oel-Aktien-Gesellschaft

I. *General Boundaries*

The Graz Basin, also called Styrian Basin, is the third major unit of Austria which, by reason of its geological architecture, may be considered to be oil-prospective. It lies on the eastern margin at slope of the Alps, almost completely inside Austrian territory, and forms one of those marginal embayments by which the Pannonian Basin extends far into the Alpine body.

The Graz Basin is bounded on the northeast by the "Rechnitz Schieferinsel" (a big outcropping basement ridge) chiefly made up of Paleozoic schists, with its highest elevation, the Geschriebenstein, and on the north by the Wechsel, Masenberg and Kulmberg massifs made up of granites, gneisses and crystalline schists. On the northwest, individual ridges of the Graz Paleozoic extend far into the rolling country of the Tertiary basin. The western boundary is formed by the great crystalline mountain mass of Koralpe whereas on the south the basin extends to the Possruck composed of crystalline and Paleozoic schists.

The eastern and southeastern boundary is formed by the morphologically little conspicuous South Burgenland Swell, a basement ridge which is largely covered by Tertiary deposits and proved by gravimeter surveys and which, on the surface, is characterized by individual outcropping basement islands made up of Paleozoic schist. That high zone which extends from Rechnitz via Eisenberg, Gussing, St. Anna, Mureck as far as the eastern spurs of the Possruck, separates the Graz Basin from the Small Hungarian Plain proper. (Fig. 1 and 2).

The Sausal Swell, a ridge partly covered by Tertiary sediments, which extends from the Plabutsch Mountain west of Graz through the Sausal Mountains in direction from north to south, divides the Graz Basin into two parts, viz. the smaller and shallower West Styrian and the considerably larger and deeper East Styrian Basin.

II. *Geology*

A. *Sequence of Strata.* According to the present status of our knowledge, the Graz Basin is made up of the following members:

a) *Basement.* The basis of the Miocene-Pliocene sequence of strata consists of the crystalline rocks of the central zone of the Alps, and of the Paleozoic series as are outcropping in the aforesaid border mountains of the Graz Basin.

b) *Tertiary Basin Sediments.* The bulk of the Neogene sequence of strata of the Graz Basin consists of a rich alternation of fluviatile-limnic, brackish and marine gravels, sands, shales and nullipore limestones, which by reason of their fossil content are to be assigned to the Miocene (Burdigalian-Helvetian-Tortonian-Sarmatian) and to the Lower Pliocene (Pannonian). The total thickness of that complex of strata shows extreme variations and, according to the reflection seismic surveys of Rohoel-Gewinnungs A.G., amounts on the east, within the zone of the Furstenfeld part-basin, to 2,500—3,500 m.

As the petrographic facies of the sediments of the Graz Basin and the salt content of their depositing medium (marine-brackish or fluviatile-limnic), particularly of the beds of Miocene age, are of utmost importance for judging the oil prospects of that tectonical unit, brief reference is made to the facies development of the various stages in the individual part-areas of the basin.

To the Lower Miocene (*Burdigalian*) are assigned, in the southern part of the West Styrian Basin, the Radel torrential gravel and the lower part of the Eibiswald beds. As these are completely made up of fluviatile-limnic deposits, they are of no oil-geological interest.

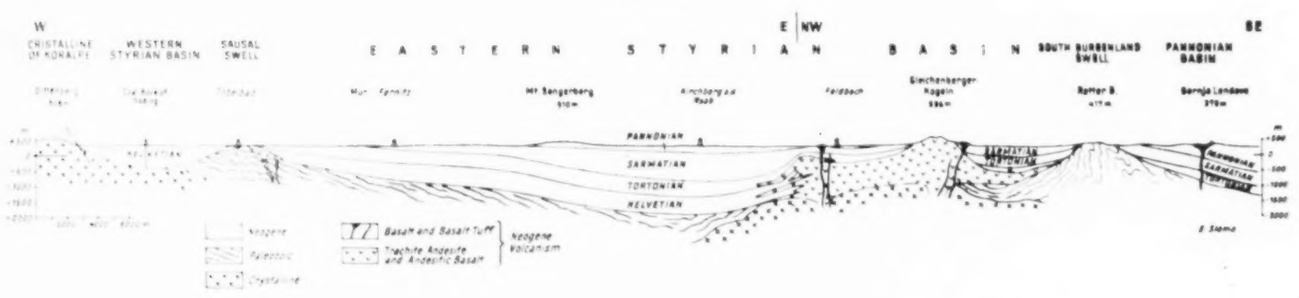
At the eastern foot of the Wechsel Mountain and in the West Styrian Basin, the Helvetian beds have chiefly the facies of coal-bearing fresh water beds, with the coal seams of Koflach, Voitsberg and Wies presently being mined.

Southeast and south of the Sausal Mountains, the Helvetian complex of strata is made up of marine, more or less sandy shales, the so-called Styrian schlier, with occasional intercalations of andesitic tuffs, in form of layers or veins. Interfingering with the schlier are thick sands and gravels such as the Arnfels conglomerates and the Leutschach sands.

Our information on the Helvetian in the East Styrian Basin is derived from the deep wells Mureck 1, Perbersdorf 1 and Ubersbach 1. On basis of I. Küpper's study of the microfauna, the well Perbersdorf 1 drilled in 1953 by R. K. van Sickle, penetrated from 930 to 1,470 m fluviatile-limnic sands, gravels and conglomerates with individual shale layers. These are overlain from 440 to 930 m by marine shales and sands with individual gravel layers, in which there are repeated intercalations of many meters thick andesitic tuffs and tuffites. According to the reflection seismic surveys of Rohoel-Gewinnungs A.G., the Helvetian beds in the middle and northern parts of the East Styrian Basin likewise show thicknesses of more than 1,000 m. The deep well Ubersbach 1 encountered the Helvetian beds from 1,582 to 2,636 m, predominantly hard shales with layers of sandstones and conglomerates, in the upper part marine, in the lower part limnic-fluviatile, with thin glance coal seams and bituminous marls with freshwater gastropods. The thickness of the Helvetian sediments decreases towards the marginal zones of the East Styrian Basin on the north and west

Fig. 2

GEOLOGICAL CROSS SECTION THROUGH THE STYRIAN BASIN
K. KOLLMANN



and towards the South Burgenland Swell as well as towards the Gleichenberg volcanic massif: in immediate vicinity of those marginal zones, the Helvetian sediments thin out completely.

Unconformably overlying the Helvetian deposits is the *Tortonian* complex of strata which, similar to conditions in the Vienna Basin, has a predominantly marine facies and in the well explored marginal areas shows a rich division in respect of facies. In the West Styrian Basin, there are of tortonian age the Florian beds, an alternation of shales—mostly rich in fossils and sands, on the southwest the Kreuzberg gravels, in the farther environs of Wildon thick nullipore limestones and nullipore calcareous sandstones. In the East Styrian Basin, the well Perbersdorf 1 penetrated marine shales with numerous sand and sandstone layers from the surface to a depth of 440 m. The well Ubersbach 1 encountered the Tortonian sediments from 1,023 to 1,582 m in a more strongly sandy facies with thick conglomerates at the base. In the deeper parts of the basin, a Tortonian thickness of 600 m may be expected.

Beds of *Sarmatian* age have been explored in a wide belt on the north, west and south of the East Styrian Basin. There are involved chiefly yellowish-brown and grayish-green, partly sandy clays and shales in which there are intercalated, predominantly in the middle and upper parts, thick sands, fine gravel and gravel as well as calcareous marl and calcareous sandstone layers. The brackish Sarmatian beds often contain a rich foraminifera, ostracod and molluskan fauna. Their thickness shows extreme variations and in the depressions of the Basins may reach a value of maximum 900 m.

The surface of the middle and northern parts of the East Styrian Basin is made up for the most part of *Lower Pliocene/Pannonian* beds. The Lower and Middle Pannonian beds chiefly consist of gray, brownish-gray and greenish-gray clays and shales as well as fine sands, with gravel intercalations in individual zones. Upper Pannonian sediments are outcropping only in the northeastern part of the East Styrian Basin.

In the Middle part of the Graz Basin, the Pannonian reaches a thickness of 300—350 m, in the eastern part 700 m whereas—within the zone of the downthrown block of the Inner Alpine Vienna Basin—it is represented by a complex of strata more than 1,000 m thick.

The youngest beds consist of Quaternary deposits, terrace gravels, sands and loams.

In the Graz Basin, contrary to the Vienna Basin, volcanic rocks are abundant which belong to two eruptive cycles.

The trachyte andesite rocks (Gleichenberg Kogeln) are of Helvetian and lower Tortonian age. They seem to rest as wide volcanic domes partly direct on the Pretertiary basement and, judging by the geophysical surveys, are much bigger at the base than at the surface.

The basalts and basalt tuffs occur in the form of pipes and lava sheets. They penetrate the entire sequence of strata of the

GEOLOGICAL MAP OF THE STYRIAN BASIN

ACCORDING TO K. KOLLMANN, A. WINKLER-HERMADEN AND OTHER AUTHORS

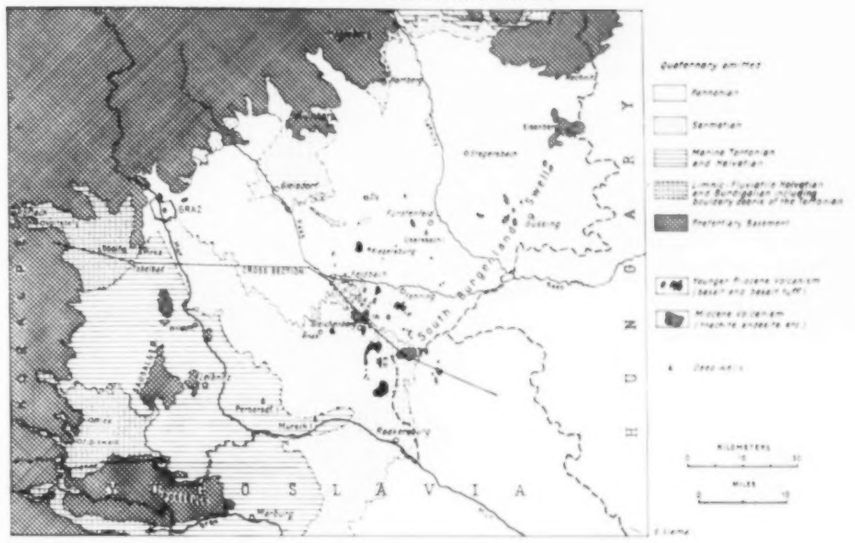


Fig. 1

Styrian Basin and are of post-Pannonian, very probably Dacic age.

B. *Structure*—The structures of the Graz Basin are chiefly due to buried basement ridges and eminences. Its origin seems to have been caused by a more or less faultless depression on which was gradually deposited a cover of sedimentary rocks 2,000—3,500 m thick. Major faults similar to the Steinberg fault in the Inner Alpine Vienna Basin have so far not been proved by the reflection seismic surveys of Rohoel-Gewinnungs A.G.

According to the present status of our knowledge, the following high and trough zones were ascertained:

As previously mentioned, the West Styrian Basin is separated from the East Styrian Basin by the Sausal Swell. The basement mass of the Kulmberg Mountain extending far to south, continues in the high zone of Gleisdorf-Arnwiesen-Funfing and in the swell zone between the part-basins of Gnas and Fehring. Another NW-SE striking buried ridge separates the Fehring Basin from the Furstenfeld Basin within which the deep well Ubersbach 1 was drilled. Other high zones are formed by the major trachyte andesite massifs (Gleichenberg and Landorf) towards which the Tertiary beds are rising and often pinching out.

III. *Oil Prospects*

In judging the oil prospects of the Graz Basin, attention is to be paid mainly to the facies and thickness of the individual members of the Tertiary basin sediments. Unfortunately, that complex of questions cannot be answered unambiguously, due to the small number of deep wells so far drilled.

In the West Styrian Basin, the Helvetian is exclusively of limnic-fluviatile facies. While the Tortonian has a mostly marine facies, its thickness amounts to few hundred meters only. The younger beds are confined only to individual insignificant occurrences. Therefore, the oil prospects for that part-basin cannot well be judged.

In the East Styrian Basin, conditions are considerably more favorable. There, the Helvetian reaches a thickness of over 1,000 m. On the south of the Sausal Mountains, the Helvetian for the most part shows the facies of the Styrian schlier. In the deep wells Mureck 1, Perbersdorf 1 and Ubersbach 1, the lower half of that stage has a limnic, partly sandy-gravelly facies. The deep well Ubersbach 1 encountered remarkable oil shows in the Helvetian whereas such were found by the deep well Perbersdorf 1 in the Tortonian only.

At the surface, oil and gas shows have been observed in the Graz Basin at two places only, viz. at the exposure of Klapping at the Tortonian Sarmatian contact, and at the Weisseneck quarry near Wildon, in a calcareous sandstone layer of the Tortonian.

IV. *Exploratory Activity*

Since the end of the war, extensive exploratory operations in the Graz Basin were carried out by three firms, viz.:

1. By the Soviet Mineral Oil Administration: geological mapping and structural drilling in the farther environs of Eisenberg and Gussing;

2. By R. K. van Sickle: geological mapping, structural drilling, and the deep test Perbersdorf 1;

3. By Rohoel-Gewinnungs A.G.: extensive mapping, reflection seismic surveys, and the deep test Ubersbach 1.

At present, oil-geological investigations are being made only by the latter company.

Extensive and costly operations are still necessary in the Graz Basin before it will be possible to judge the oil prospects of that tectonical unit.

The "blue Danube" River in Austria. Photos: Courtesy of Prof. G. A. Fenz—Austria

PETROLEUM TRANSPORT ON THE DANUBE

Transportation by tanker on the Danube developed greatly after the first world war. Many shipping companies of importance participated. Up to 1938 the D.D.S.G., together with other shipping enterprises such as Bayerische Lloyd, Schiffahrts A.G. in Regensburg and Continental Motorship Transport Co., A.G., in Vienna, and capacities of a total of 70,000 tons in service. Among these were 39 tankers, belonging to D.D.S.G. and 65 tankers with 44,500 tons to the other companies.

Besides these were Czechoslovak, Yugoslavic and Romanian enterprises. Originally mostly, the Romanians transported oil to refineries in western Danube lands. The subsequent opening of Hungarian and Austrian oil fields made larger demands on the Danubian traffic. In 1943 the above-named companies carried 500,000 tons of oil. The big production of Austrian fields after the second world war controlled by the occupying powers greatly enlarged the traffic. However, the Austrian tankship traffic was unprofitable. On the contrary, the companies were obliged, without regard to their own interests, to operate part of their tanker fleet for the transport of dry commodities only on short hauls west of the occupation zones.

It was not until 1954 that about 14,000 tons of fuel oil could be carried from Romania to the west. But even today there is no continuous transport out of that country.

The Austrian State Treaty of 1955 imposed obligations on Austria. The Soviets assigned these to the ship companies of the eastern Danube countries. The Austrian companies were restricted to inter-Austrian transport for Austrian refineries and even this was curtailed when the pipeline from the Lobau to Korneuburg was built.

The increase of Romanian oil production to about 12,000,000 tons per year, and the efforts of Russia to bring more Russian production onto the European market holds a prospect for increased tanker transport on the Danube. On the basis of an agreement recently signed in Moscow, the Austrian tanker fleet may in coming years participate in the transport of Russian crude oil to Austria.

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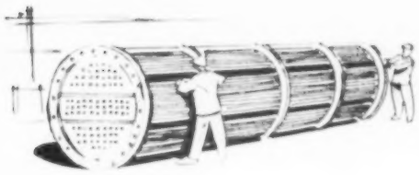

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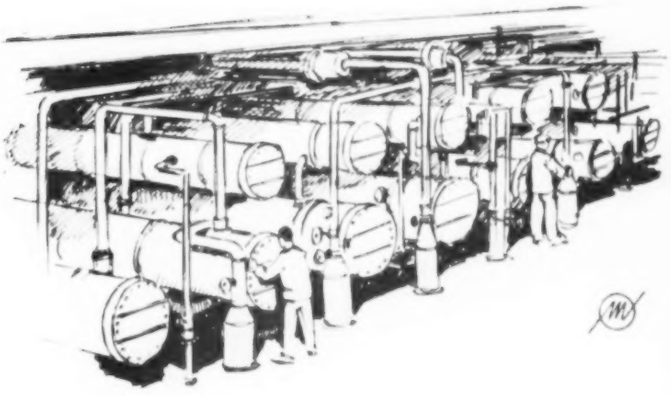

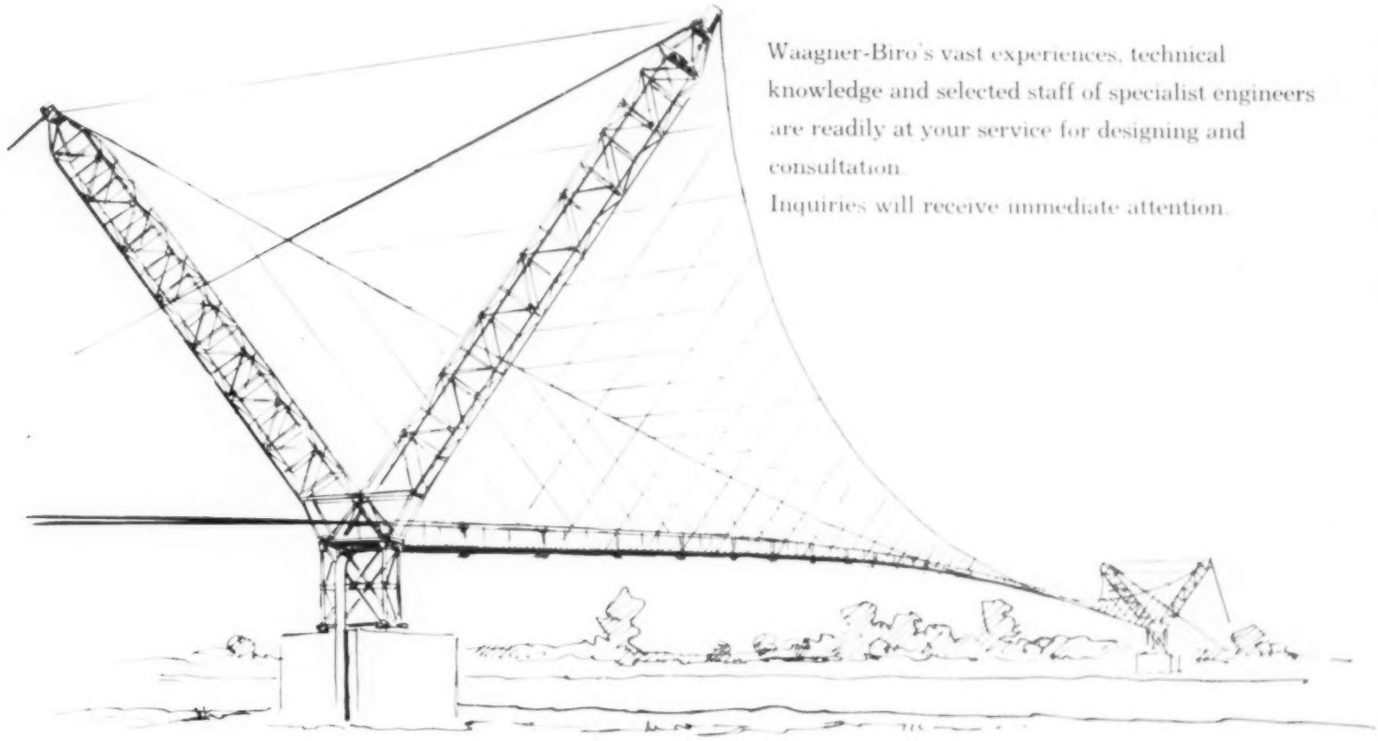

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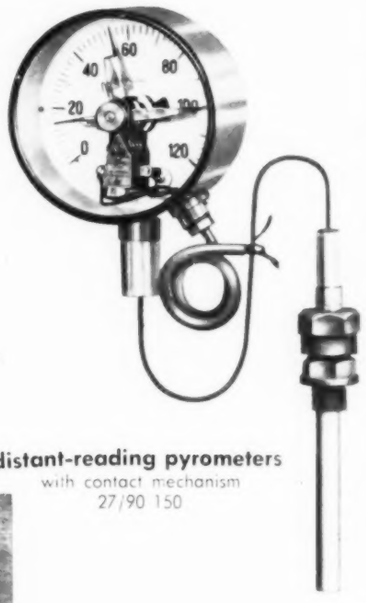

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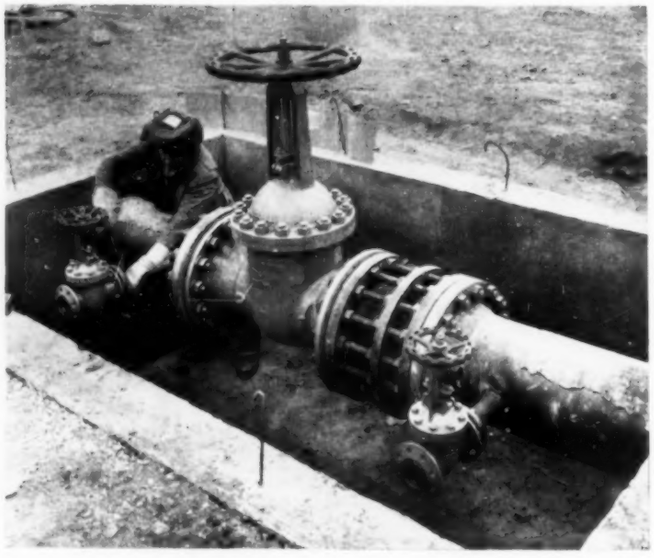

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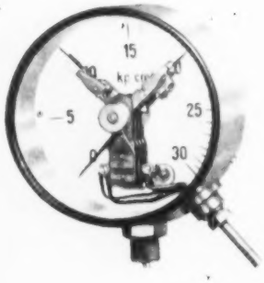

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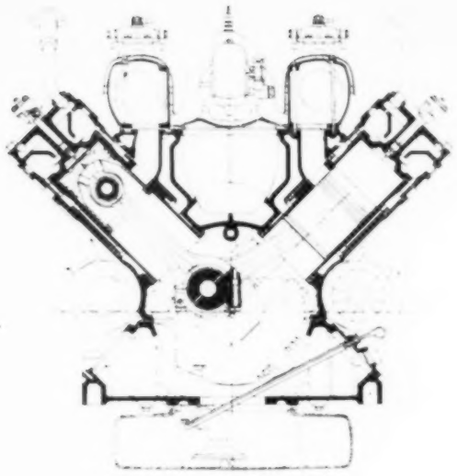
TWO STROKE ENGINES FOR HEAVY DUTY

by Dr. Ing. Robert Söllner

JENBACHER WERKE • Jenbach, Tirol, Austria



THE "Jenbacher Werke" is built on a very old tradition as iron works, foundry, machine builder, plane and engine factory, has been considerably enlarged in recent years for the production of modern, high speed diesel engines and heavy duty diesel engines with auxiliaries and vehicles. The "Jenbacher Werke" pioneered specially in the development of the high speed two-stroke diesel engines with loop scavenging. Because of this their engines have reached a high state of technical efficiency.

Technical description

The company's output embraces several types of diesel engines, of which some two-stroke engines are described here. These have uniformly three litres piston stroke volume and a normal speed of 1500 rpm. The cylinder output of the engines is 50 bhp. Therefore the 600 bhp engine has 12 cylinders. The output of this engine can be brought up to 800 bhp at 1500 rpm by an exhaust turbo blower.

The cast iron crankcase is constructed so that the whole tensile load is carried by special steel screws, which are fitted between the cylinder heads and the main bearings. The short piston stroke of 6.69 in. reduces the piston speed to 27.8 ft/sec. The result of this low piston speed is long engine life. In addition to the particularly solid construction of the wet cylinder liners, made of centrifugally cast iron, the engines feature alloyed light metal pistons and forged connecting rods and crankshifts. Maintenance is very simple because individual cylinder heads may be removed for easy top removal of pistons. Driving parts of the Jenbach type engines which range from 50 to 600 bhp are standardized so that nearly all are interchangeable. Only three moving parts are left: pistons, connecting rods and crankshafts. The Jenbach two-stroke engines are supplied with loop scavenging and have no valve control.

This permits a longer interval between general overhauls. Practical experience has shown between 12,000 and 15,000 working hours between overhauls.

Particular attention has been given to perfect cooling of all engine parts, which come in contact with combustion gases. Cooling water flows along the cylinder liner through water passages and cools the inlet and exhaust ports on its way to the cylinder head.

As mentioned above, the cylinder liners are scavenged without valves. The piston regulates the opening and closing action of the ports. All wear on valve mechanism parts is avoided and this also makes the maintenance of the engine easier. The right quantity of fuel is delivered to all multi-hole injection nozzles, fitted on the cylinder heads, which spray the fuel directly into the combustion chamber by an injection pump equipped with a speed governor. The new series of piston heads are flat. The light metal alloy, which speeds heat dissipation and the four highly expanded piston rings are designed to keep pistons cooled even when operating under heaviest loads. Lubricating oil is delivered to all points of lubrication with regulated oil pressure by a gear oil pump, fitted in the crankcase which takes suction from the oil pump.

Perfect lubrication of all moving parts is attained by the short and compact construction of the engines, as well as by plentiful oil supply and intensive cleaning. Oil heat exchangers are supplied for engines with four or more cylinders. As a result of this development it has been possible to reduce oil consumption to 0.5 g bhp-hr at full load and to extend the oil change time to 300 hours. Commercial grades of heavy duty oils without additives are used. The fuel and the oil are, of course, carefully filtered.

Comparison of Working Systems

Technical advantages of the two-cycle engine are clearly seen since the two-stroke cycle makes twice as many working strokes and is simpler in construction than the four-stroke cycle operating at the same speed. Using the technical experience of the last 40 years, the gas change process of the two-stroke engine has been so improved that it is equivalent to the modern types of four-stroke engines. Success of the two-cycle engine has resulted from the higher engine output expressed in terms of bhp per liter of the two-stroke engine, its quieter operation and a specific fuel consumption which cannot be matched by a four-stroke engine.

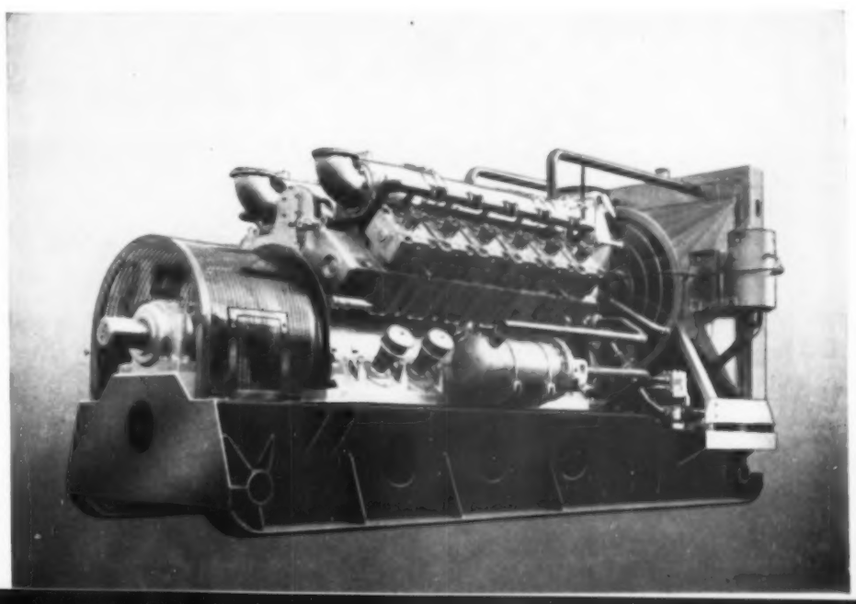
Valves of diesel engines are especially subject to high wear by the high pressure and temperatures in the combustion chambers. This was one cause of concentration on the development of reliable two-stroke diesel engines with long running time. Additional advantages are the smaller dimensions and lighter engine weight. Because of this the two-stroke diesel engine for ships was competitive with the four-stroke engine twenty years ago.

At the moment, loop scavenging, which works without valves and other wear parts has been found to be the best solution. This development has come through the pioneer work of the "Jenbacher Werke". The engines work so reliably because of their small dimensions and low weight and because of extremely low wear and high efficiency, that they are used with full satisfaction as stationary and vehicle engines and on drilling rigs, locomotives and ships.

Continuous test stand runs

During development of the present construction types, continuous test runs were made with individual engine types. The "JW 400" and "JW 600" each had a continuous test run of about 3,000 hours.

All test engines were coupled to a three-phase synchronous generator with a corresponding capacity which absorbed their power output through the generator.



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Specifications of test engines

Diesel engine without turbo load	"JW 400"	"JW 600"
Type number	1120	1102 A
Working cycle	two-stroke with loop scavenging	
Number of cylinders	8	12
Cylinder bore	5.91 in	5.91 in
Piston stroke	6.69 in	6.69 in
Capacity	24 l	36 l
Maximum output B (DIN 6270) at the clutch	400 bhp at 1,500 rpm	600 bhp
Engine weight dry	4520 lbs	6175 lbs
Lubricating oil quantity	8.3 Imp. gal.	18.2 Imp. gal.

Commercial quality of fuel with a calorific value of 18,000 Btu lb and an API density of 33—37° has been used. HD oils type A in the viscosity class SAE 30 were used for the lubrication of the engines.

The continuous test runs were begun after a running-in time of about 50 hours at mounting load and two oil changes after 20 and 50 hours of running.

Test results

Continuous test running with	"JW 400"	"JW 600"
Speed	1500 rpm	1500 rpm
Generator output	260 kW	400 kW
Generator efficiency	91 %	92.5 %
Effective engine output (average)	389 bhp	588 bhp
Atmospheric pressure (oscillating) between	27.15/16 in.M.	27.9/16 in.M.
	28 5/8 in.M.	28.5/8 in.M.
Air temperature (oscillating) between	46.5—82.2 F	35.5—80.5 F
Room temperature (maximum)	113 F	112 F
Output (average)	400 bhp	602 bhp
Engine oil change	after 100 to 120 hours	after 200 to 210 hours
	(engine stopped for 1 to 2 hours)	
Fuel consumption	17¼ Imp. gal.	25½ Imp. gal.
Fuel consumption, average	0.348 lb bhph	0.344 lb bhph
Fuel consumption total	52,000 Imp. gal.	765,000 Imp. gal.
Oil consumption 0.39 lb h or an average of about	0.90 lb bhph	1.06 lb bhph
Filled oil quantity while running	902 lb	1520 lb
For 27 engine oil changes	2380 lb	—
For 27 engine oil changes	—	2640 lb
Total	3282 lb	4160 lb

Temperature during service:

Cooling water	157 F—185 F	
Lubricating oil	176 F—203 F	
Exhaust	581-643 F	608-643 F

Economic data for each test run follows:

Diesel engine	"JW 400"	"JW 600"
Total energy output, 3000 hours	782,240 kWh	1,201,500 kWh
Fuel consumption, 3000 hours	51,811 Imp. gal.	765,000 Imp. gal.
Lubricating oil consumption	3,290 lb	4,170 lb
Returned draining oil	1,870 lb	2,430 lb

Dismantling of the engines after the test runs show the following condition of driving parts:

By using HD oils with detergent additives the inside of the engine was almost completely clean. It was observed that the deposits were very small on the pistons and in the ports. During the test runs the engines were smokeless, even when the atmospheric pressure dropped or the atmospheric temperature rose considerably. All wear parts were cleaned and tested. It was found that all measurements, except some piston rings were still within production tolerances. The worn out piston rings must have been very close to the top tolerance of piston rings clearance at the beginning of the test runs. The tolerance was exceeded by wear during running in. The pistons and cylinder liners appeared perfect except for a few dirt grooves. The terminal of the first compression ring in the cylinder liner showed a nearly intangible step caused by the running-in wear. The bearings, with lead bronze and a soft bearing metal for the running-in, showed only the normal annealing color and some dirt grooves. The soft bearing metal (thickness 0.0003 in) was not pressed through or worn out at any point. This means, that there was a hydrodynamic oil film on the whole bearing surface which secured a continuous swimming friction. Also during engine start-up the pressure rise of oil circulation, which is delivered by an oil pump, must have come so quickly that no considerable wear occurred.

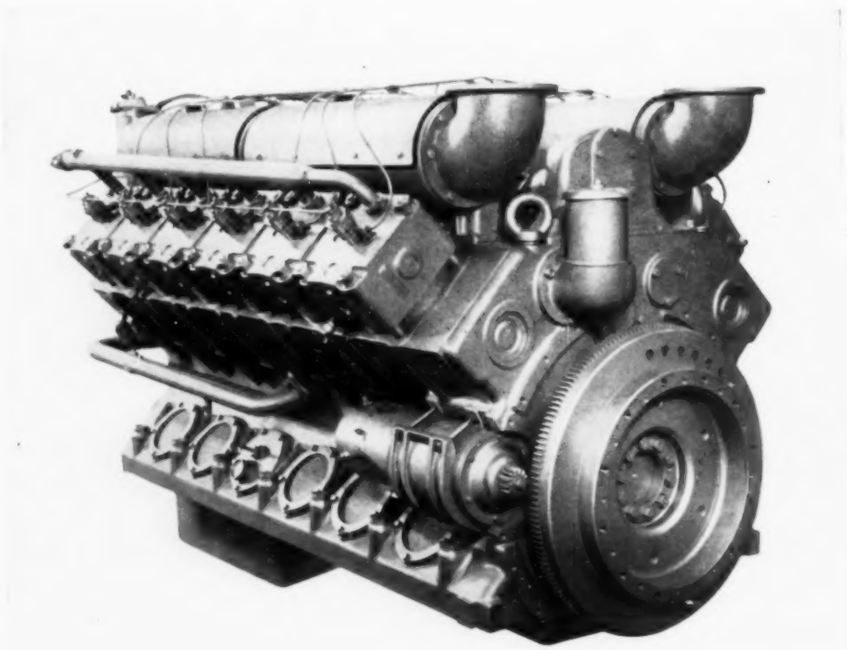
Crankshafts did not show any wear either on the crankshaft pin or connecting rod pin, or on the wear surfaces of the oil seals. Also the special oil seals were still unchanged. Wearing surfaces of the oil seals leaked no oil during the test runs.

The injection equipment worked perfectly during the 3000 hours. It was favorable that the fuel was taken from a big underground tank, in which all the mechanical dirt had settled. The injection pump and the injection nozzles were not changed or adjusted during the test runs. The injection pump and the injection nozzles were tested at the conclusion of the runs and showed normal edge life. The injection nozzles were found to give perfect opening pressures.

Summary:

Dimension changes which were established within very narrow limits showed that all wearing parts of the engine, including the known running-in wear will reach at least a running life of 10,000 working hours. This means that after an intermediate control at 5,000 hours a general overhaul need not be done before 10,000 working hours or on shift work not before 5 years. This presupposes, of course, perfect maintenance, especially proper engine lubrication and the right cooling water temperature.

The commercial data are remarkably favorable.



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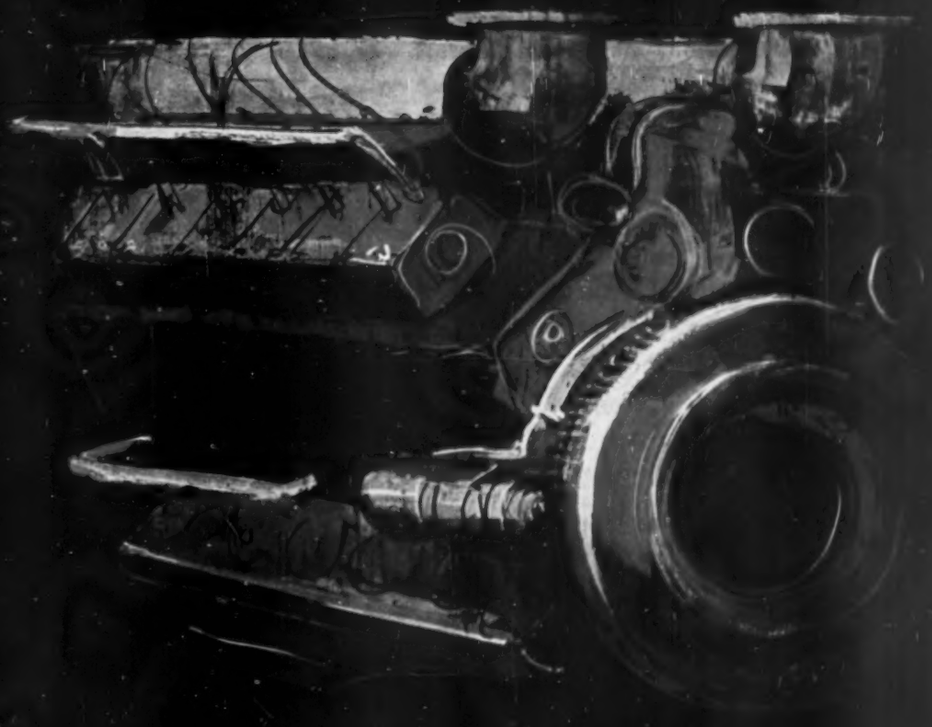

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QUALITY ASPECTS OF SUCKER RODS

by H. Souresny, Head of the Research Development Department,

Schoeller-Bleckmann Steelworks Ltd., Vienna, Austria

A STRING of sucker rods represents a complicated system of power transmission which, in most applications, is exposed to corrosive attacks. It is obvious that great care has to be exercised in the manufacture of all elements of the pumping string to obtain economy in service.

Since the standardization of sucker rod geometry through API, material aspects have been the main concern of oil producers, both with regard to the mechanical properties as well as to the corrosion behavior of the rods. Due to increasing pumping depths, sucker rods become subject to increasingly higher mechanical stresses. Consequently, straight carbon-steel sucker rods with comparatively low tensile strength which originally were used almost exclusively have largely been replaced by high tensile rods made of moderately or even more highly alloyed steels. Further points, the importance of which has by now been recognized universally are mechanical processing as well as heat treatment for the attainment of maximum service life. Whereas formerly the unalloyed sucker rods were not heat treated at all, except for a possible normalizing operation of the ends, at present practically all manufacturers subject rods to full length heat treatment in order to obtain optimal mechanical properties over the entire length. The surface quality is improved by such measures as shot-blasting and plastic coating which ultimately will result in better overall performance.

Table 1: Suggested Sucker Rod Steels.

Steel No.	C	Si	Mn	Cr	Ni	Mo
1	.25	.15	.60			
	.42	.30	.90			
2	.30	.15	1.20			
	.40	.30	1.50			
3	.30	.15	.50	.30	.40	.50
	.40	.30	.90	.60	.80	.75
4	.30	.20	.60	.55	1.10	
	.40	.35	.90	.90	1.75	
5	.13	.20	.45		1.65	.20
	.23	.35	1.00		2.00	.30
6	< .23	.20	.40		3.25	.15
		.35	.70		3.75	.30
7	.08	.20	.40	1.40	3.25	
	.13	.35	.60	1.75	3.75	
8	.05	.15	.30		8.00	
	.13	.30	.50		10.00	

Table 1 shows the chemical composition of some steel brands which were originally suggested by API as possible sucker rod steels. As can be seen, nickel, chromium, manganese and molybdenum are proposed as alloying elements. The carbon content is kept at the minimum required to obtain the strength desired. Nickel, due to its generally known favorable alloying characteristics, is most desirable. It effects a finer grain structure and has no tendency of fibre formation. It increases the steel's toughness and does not form carbides. Chromium is mostly used in combination with nickel. It increases strength more than nickel; on the other hand, it does not have its effects in the basic steel matrix as is the case with nickel, but forms carbides. The main function of manganese is to increase strength. It has the disadvantage of rendering the steel more sensitive to overheating, and of promoting fiber formation. Nevertheless, moderately manganese-alloyed steels which were preferred originally due to the shortage of nickel, have yielded excellent service. Molybdenum, likewise, increases strength and suppresses tempering brittleness. It is employed mainly in combination with nickel for high grade sucker rod steels.

Steel No. 1 represents a straight carbon steel to AISI 1030. Its applicability is limited due to the comparatively low tensile strength; currently, for non-corrosive well conditions, steels with an alloying rate at least corresponding to steel No. 2 (AISI 1036) are being used. Steel No. 3 is a Cr-Ni-Mo alloy used under heavy mechanical stresses. For similar applications, steels No. 4 and 5 might be used as well. Steel No. 4 corresponds to AISI 3135, whereas steel No. 5 is in accordance with AISI 4615. The latter type is most popular in the manufacture of heavy duty sucker rods which are exposed to corrosive attacks. Corrosion behavior under heavy mechanical stresses may be even improved by steels similar to Nos. 6 and 7. The highly Ni-alloyed steel No. 8 is envisaged for very badly corrosive conditions, but its practical applicability is extremely doubtful due to the high alloying level.

The main problem which users of sucker rods are fighting is corrosion fatigue. Sucker rods in service frequently are exposed to heavily corrosive fluids in the form of solutions of carbon dioxide, hydrogen sulfide, or sodium chloride which considerably reduce fatigue strength and lead to repeated failures. In order to eliminate this problem, considerable research has been conducted, and various suggestions for laboratory test procedures have been made. Still, as yet we do not possess a universally accepted method for the determination and examination of corrosion fatigue with sucker rods. This is due, on the one hand, to a lack of basic data on the nature of corrosion fatigue and, on the other hand, to the difficulty of duplicating, on a laboratory scale, the great variety of practical pumping conditions.

Recent investigations have, however, made clear certain points relative to the material quality of sucker rods which should be duly recognized in the manufacture of sucker rod steels, should a favorable corrosion fatigue behavior be obtained. The grain size is to be kept as small as possible. The carbon content is to be as low as permissible with regard to the strength required. Sulphur and phosphorus are to be eliminated to the extent feasible under the aspects of economy in the production of steel. In a similar fashion, such impurities as non-metallic inclusions should be restricted to a minimum. It has further been shown that, all other conditions being equal, open hearth steels perform better than steels melted in electric furnaces. This finding might possibly be due to different contents of nitrogen or oxygen in the steel. In addition to the points just raised, surface quality of the sucker rods also does play an important role in corrosion fatigue behavior. Notches, irrespective of whether they are due to surface flaws or mechanical damage, may promote premature failures, and must be avoided with all possible care.

The Austrian sucker rod manufacturing program, with due recognition of the various criteria pointed out above, was based on the steels shown on Tables 2 and 3:

Table 2: Austrian Sucker Rod Brands, Range of Chemical Composition in Percent.

Brand	C	Si	Mn	Pmax.	Smax.	Cr	Ni	Mo
VM 125	.28	.20	1.30	.030	.030			
	.35	.30	1.50					
MP	.32	.20	1.25	.030	.030		.50	
	.39	.30	1.45				.60	
N2P	.13	.20	.60	.030	.030		1.65	.20
	.23	.35	.90				2.00	.30
HNC	.30	.20	.40	.030	.030	.50	1.40	
	.40	.30	.60			.70	1.70	
N3P	max.	.20	.40	.025	.025	3.25	.15	
	.20	.35	.70			3.75	.30	

Table 3: Austrian Sucker Rods, Minimum Mechanical properties.

Brand	Yield point psi	Tensile strength psi	Elongation $l = 8\,d$ %	Reduction of area %	Impact strength (DMV Test Bar) mkg/cm²	Endurance limit, air psi
VM 125	60000	90000	18	50	10	52000
MP	67500	95000	13	50	8	52600
N2P	65000	82000	20	60	12	55000
HNC	100000	126000	12	55	10	65000
N3P	75000	90000	18	60	10	60000

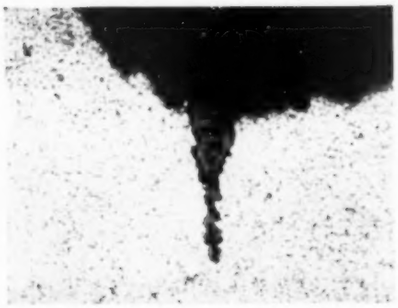


Fig. 1: Incipient failure, starting from a corroded spot.

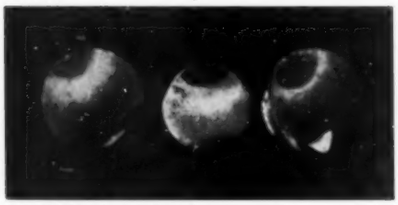


Fig. 2: Sucker rod failures, starting at corroded surface flaws.

The raw material for the manufacture of sucker rods is rolled bar stock, carefully melted in a small grain size. Stress is laid on a superior surface quality in order to preclude the existence of inclusions, seams, cracks or other flaws that might lead to premature fatigue failures in service. The rolled bars are heated at the ends to forging temperature, and the ends are upset on forging machines in a sequence of operations. It is of importance to control the individual operations in such a way that the fiber flow lines are favorably arranged, and that the formation of forging defects is prevented. The forging dies must guarantee well-rounded edges and radii, as well as the most favorable end geometry for the attainment of maximum strength.

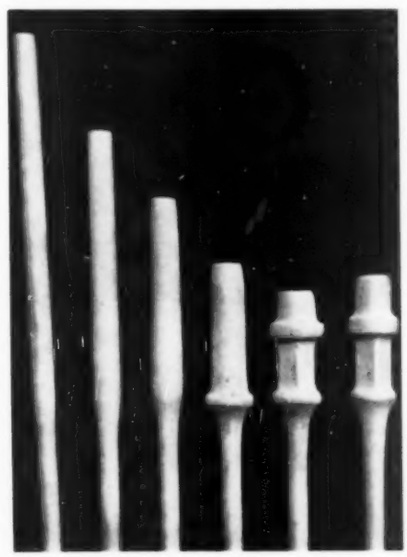


Fig. 3: Forging steps in the manufacture of a sucker rod end.

Figure 3 shows the successive steps in the forging of heads. For the sake of maintaining the desired grain structure, exactly predetermined forging temperatures must be strictly adhered to. Overheating through excessive forging temperatures or through too long an exposure to same affect physical properties most adversely and, in particular, reduce toughness considerably.

Figure 5 shows the effects of such overheating. After the forging of the ends, the sucker rods are heat treated full length; heat treatment consists in normalizing only, normalizing and annealing to a certain strength level, or in quenching and subsequent tempering. Following a series of tests for the determination of physical properties (including tensile and impact tests), the sucker rods are straightened.

The straightening process is of great importance, inasmuch as service requirements demand sucker rod strings of great straightness. Normal bar straightening machines appear to be unsatisfactory because of the upset ends. Similarly, punch-straightening does not fully satisfy either, because punch-straightened rods are never fully aligned and, furthermore, the human element involved in the process is pronounced.

It could be shown that these difficulties may be overcome by the adoption of a special type of stretch straightening. Straightening is effected by the application of a tensile load which is above the yield point of the respective material. Practical experiments prove that by this method satisfactory straightness is obtained in a simple manner. The disadvantage in the original process, however, was the occurrence of the so-called "Bauschinger Effect" resulting in a reduced compression yield point of the stretch-straightened rods leading to a more easy deformation of the rods during further handling in service. Further tests and experiments have, however, indicated that an additional deformation of the rods after straightening does again uprate the compression yield point to the original level.

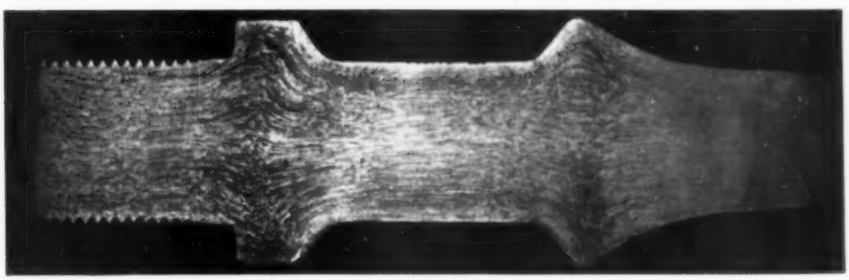
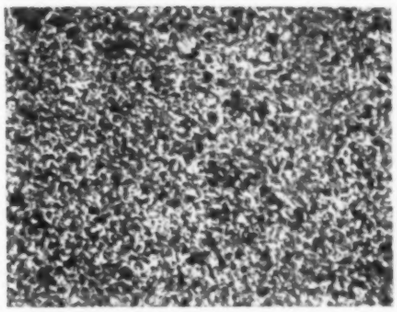


Fig. 4: Flow lines in a sucker rod end.



Grain structure of Brand VM 125, forged at correct temperature

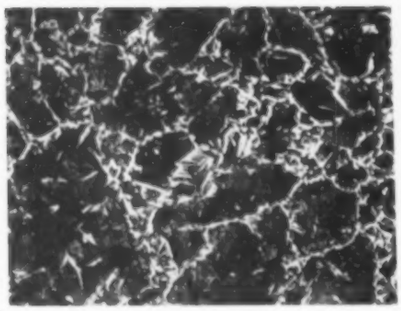


Fig. 5: Grain structure of Brand VM 125, forged at excessive temperature.

Before the general adoption of this improved stretch-straightening process, detailed and painstaking experiments of a static, as well as a dynamic nature were conducted in order to determine in which way the steel structure might be affected. The static experiments did show that stretch straightening tends to raise the yield point, whereas the tensile strength, elongation, reduction of area, and the impact strength remain practically unchanged. For the determination of the effect on the dynamic properties, the standard rotating-beam tests on steel samples were made as well as pulsation tests with long sucker rod bars. Comparative findings indicate that stretch-straightened rods, with regard to their fatigue life behavior, are superior to punch-straightened rods. These results were not surprising, because stretch-straightening allows for a better distribution of deformation loads. One further important advantage of the new method lies in the fact that defective rods can be recognized and discarded with a greater degree of certainty than with any other method of inspection.

Sucker rod couplings are usually made of bar stock from which bored sections are cut and turned. The semi-finished couplings are heat treated and then finished without threads. The surface is induction hardened in order to increase wear resistance. This hardened surface is ground; then the threads are tapped and the faces are ground at a 90° angle to the thread's axis.

The steels used for the manufacture of couplings are either of the straight carbon type or alloyed, always in accordance with the sucker rods to connect with.

As already stated, sucker rods in service are subject to a great variety of stresses. Therefore, aside from careful supervision

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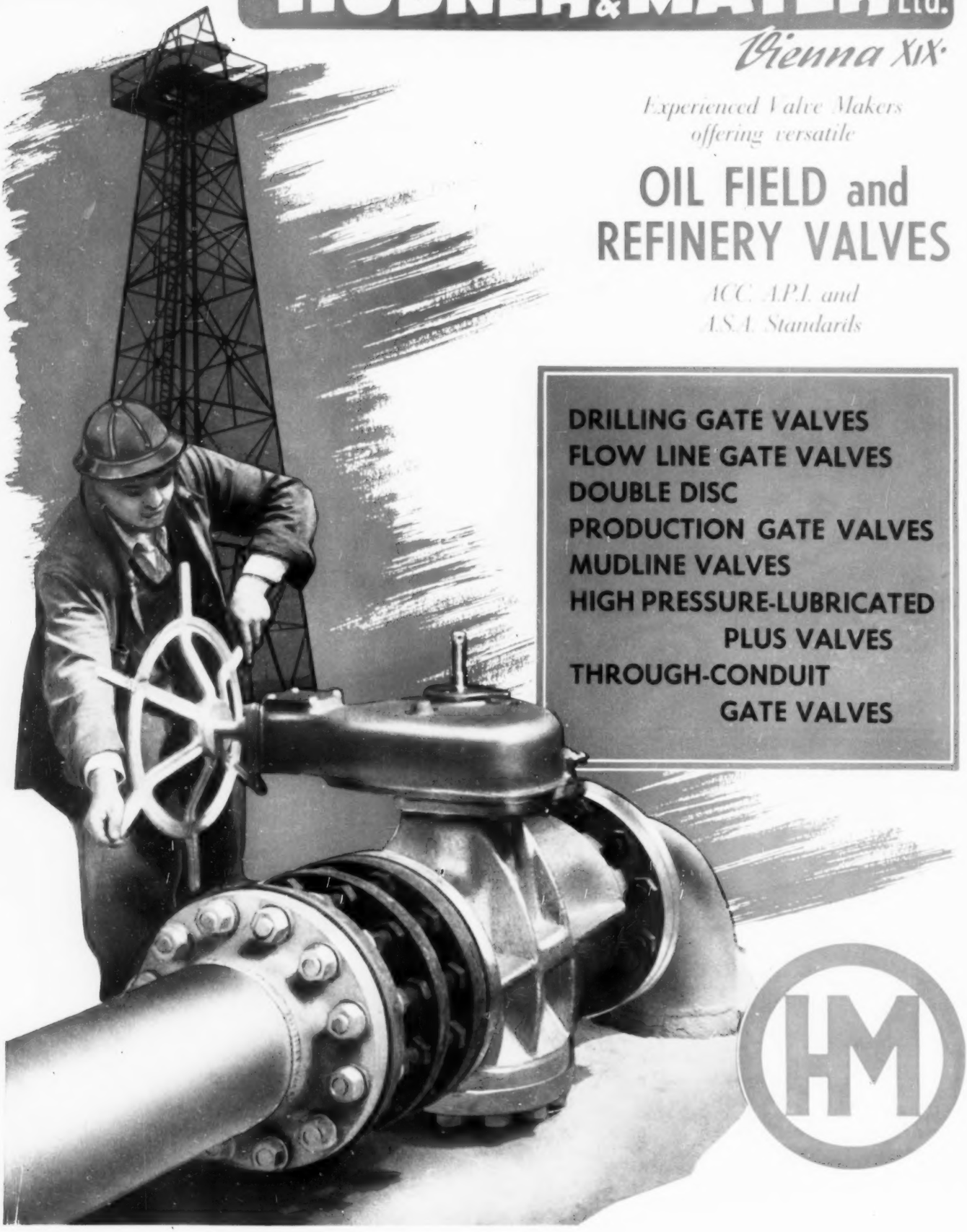

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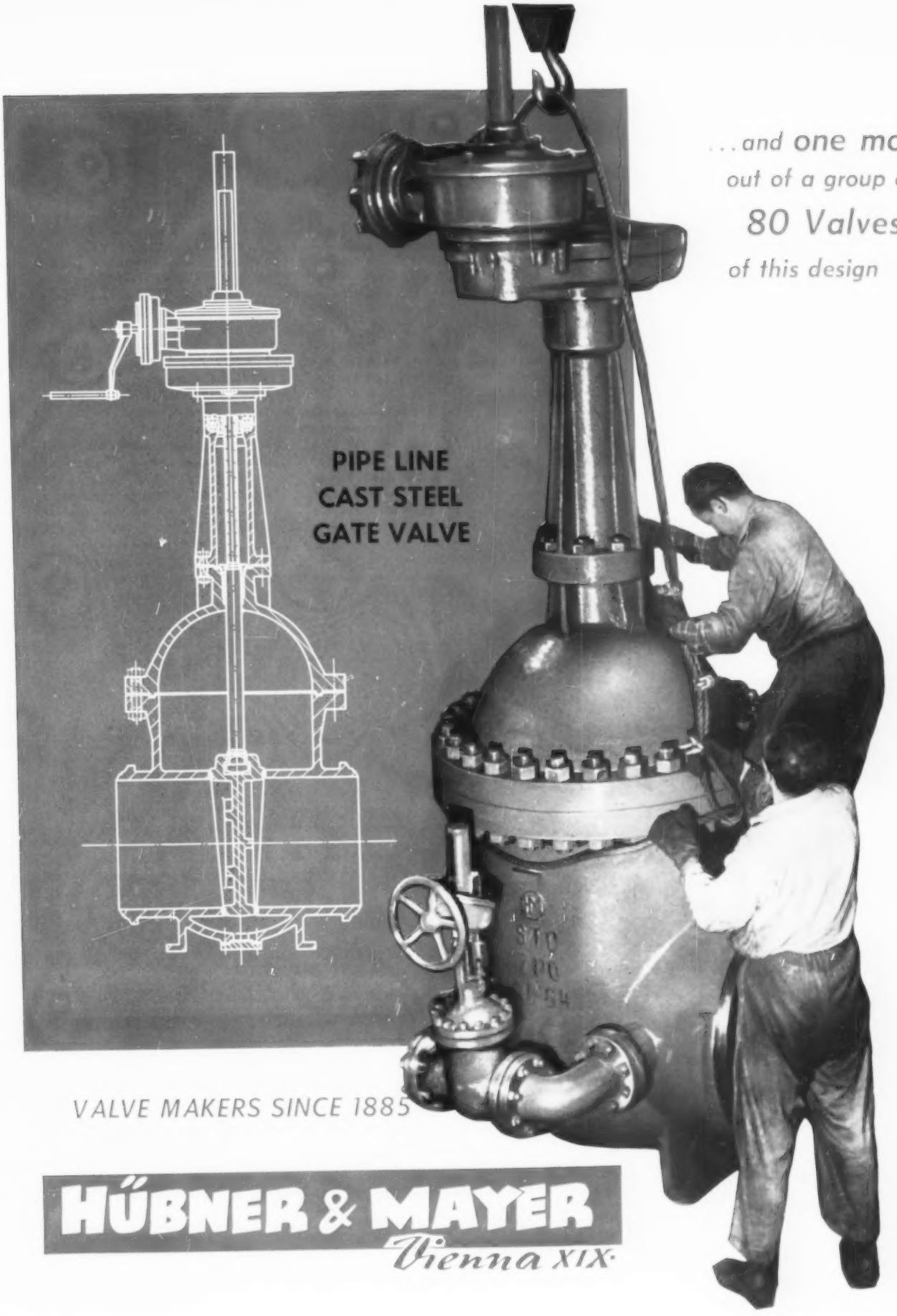

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Fig. 6: Section of a surface-hardened coupling.

and inspection procedures in manufacture, uniformity and homogeneity of the steel are of paramount importance. Preliminary agreement on the most suitable and economical brands of steel has been reached, but certain measures can be taken in manufacture to improve quality.

It is recommended practice to maintain at all times a close contact between the sucker rod manufacturer and his steel supplier. In this respect, the situation in Austria is particularly favorable because the sucker rods are manufactured by a steel works specializing in the production of alloy steels. The experience of the steel mill and its research facilities are most valuable for the manufacture of sucker rods.

AUSTRIAN REFINERIES

by Dipl. Ing. E. Hammer, Dipl. Ing. F. Kubelka, Dipl. Ing. R. Wallner*

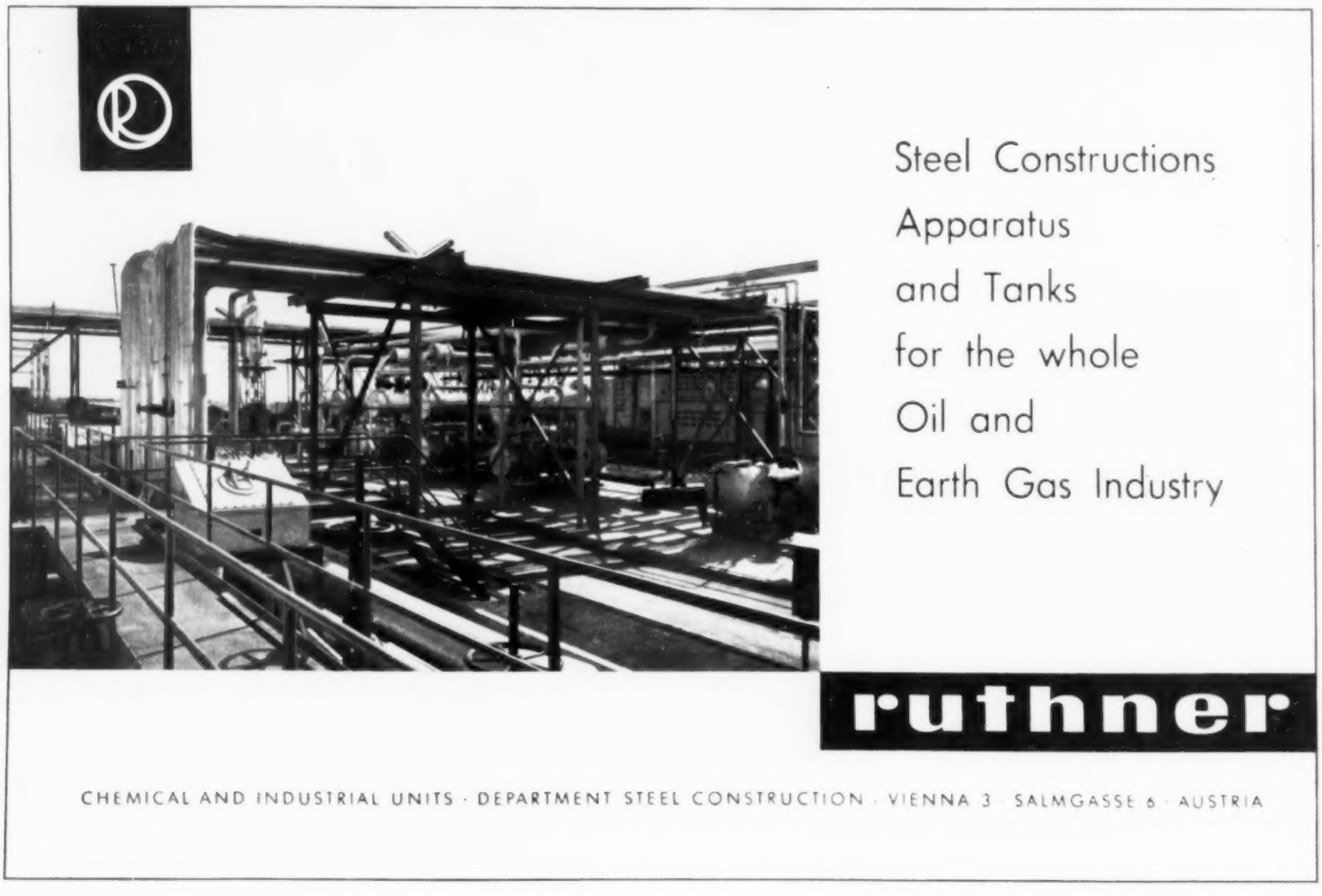
During 1864, the first Austrian refinery was built at Vienna-Floridsdorf by Messrs. Pilz and Co., only five years after the sensational drilling success of Col. E. Drake at Titusville, Penn. Thus, Austria was one of the first countries to recognize the importance of this branch of the industry and can claim to possess one of the oldest refining units in the world. This "Floridsdorf Refinery for Petroleum Products" was later sold (1929) to the Royal Dutch/Shell group and remodelled by adding new equipment, i.e. an atmospheric and a vacuum distillation unit, a lubricating oil refining plant and a bitumen installation.

Another refinery, the "Benzin and Oil Industry Kagran" G. Konig & Co. was erected at the turn of the century and later on taken over by Vacuum Oil Co. A. G. Only a few years later, a small refinery was erected at Droesing (Lower Austria), but closed down after World War I. At the beginning of World War II, the following refineries were in operation: Korneuburg, Voesendorf, Schwechat Kagran and Floridsdorf, all of which are situated in suburbs or in the vicinity of Vienna.

* Refinery Managers

Shortly before the outbreak of World War II, the erection of a new refinery at Vienna-Lobau was started, whereas another refinery unit was built during wartime at Mossbierbaum in Lower Austria: both plants were completed in the first years of the war. Two other small refining plants were constructed after 1955, the one being situated near Vienna, and the other in Neusied 1 Zaya (Lower Austria). Presently, Austria has eight refineries with a total throughput capacity of 2,345,000 tons per year. (see Table I).

During World War II most of the Austrian refineries were heavily damaged by air raids, but rebuilt at the end of the war. In addition to the normal atmospheric distillation units, the Schwechat and Moosbierbaum plants are also equipped with thermal cracking units, whereas the Floridsdorf, Kagran and Korneuburg plants are provided with units for the production and blowing of bitumen. The latter plants, as well as the Schwechat refinery, refine lubricating oils by means of sulfuric acid and bleaching earth; they also produce some grades of special gasoline. Vacuum Oil Co.'s refinery at Kagran has facilities for the production of lubricating grease and the Shell



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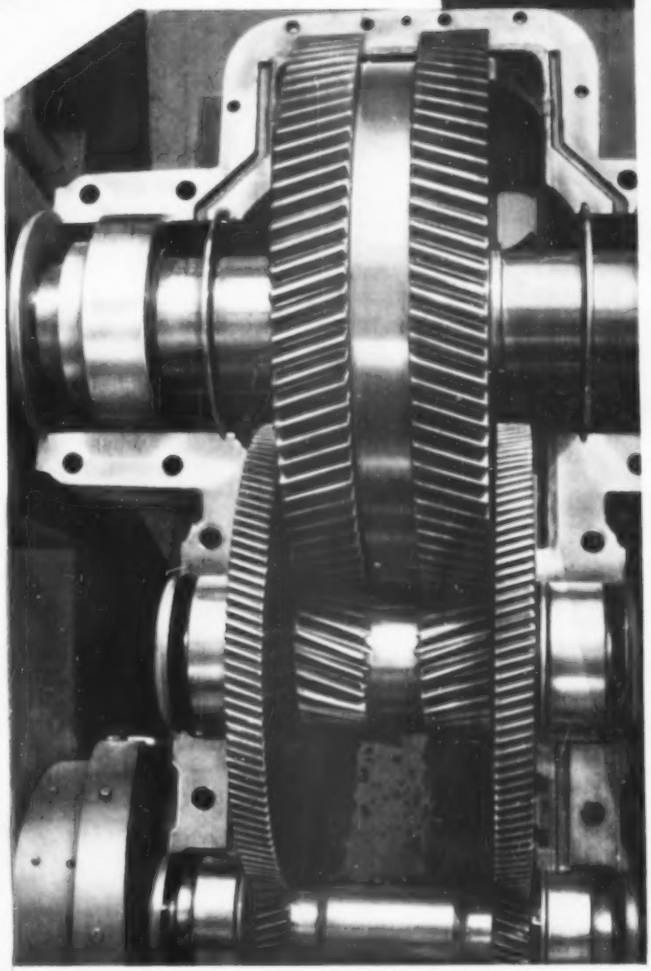

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TABLE I—AUSTRIAN REFINERIES

Location	Ownership	Throughput capacity (tons/year)
Schwechat	Oesterreichische	700,000
Moosbierbaum	Mineraloelverwaltung	360,000
Korneuburg	Aktiengesellschaft	350,000
Lobau	Austr. Mineral Oil Works (50% Socony 50% Shell)	420,000
Floridsdorf	A.G. Shell Mineral Oil Plant	230,000
Kagran	Vacuum Oil Co. A.G.	215,000
Neusiedl	R. van Sickle, Drilling contractors, Vienna	50,000
Kledering	Kledering Mineral Oil Refinery, A. Ebert	20,000
		2,345,000

TABLE II CHARACTERISTICS OF VIENNA BASIN CRUDES

Oil Field:	Matzen-Auerstahl	Muehlberg-Neusiedl	Aderklaa
Type of crude	naphthenic	paraffinous	paraffinous
Primary yields:			
S.R. gasoline	3.5% by wt	11.0% by wt	24.0% by wt
Kerosine + gasoil	36.0% " "	42.0% " "	52.0% " "
Residual oil	60.5% " "	47.0% " "	24.0% " "
Straight-run Gasoline:			
MOZ, clear	75	55	45
Gas Oil:			
Cetane No.	45	55	60
Pour Point	below —40°C	below 0°C	below 0°C

Co. built a modern grease plant at Vienna-Simmering in 1955. Due to the occupation of Lower Austria by Soviet forces during 1945, they took possession of the refineries Moosbierbaum, Kragan, Voesendorf, Schwechat and Kledering; the management was put in the hands of the "Soviet Mineral Oil Administration" (SMV). Later on (August 1947) the Lobau refinery was incorporated in the SMV organization and the Floridsdorf and Kagran refineries were SMV controlled. Thus, all Austrian refineries were either administered or controlled by the Soviets.

The State Treaty and the additional Wiener Memorandum (1955) ended this situation. The Floridsdorf, Kagran, Lobau, Voesendorf and Kledering refineries were returned to private ownership, whereas the refineries of Moosbierbaum, Korneuburg and Schwechat became State property on account of a nationalization law.

After clarification of the ownership relations, the Oesterreichische Mineraloelverwaltung (OeMV) started to plan and construct a new, modern refinery at Schwechat, its first stage having a throughput capacity of 1.6 million tons year. The operational scheme of this refinery includes the following units: atmospheric distillation, catalytic reforming, solvent extraction, dewaxing, bitumen blowing, as well as an LPG plant and an ethylene unit. In combination with the new refinery, construction of plants for the production of low pressure polyethylene and polypropylene was started. The estimated costs for the new refinery amount to 1.2 billion shillings or about $45 million. The efficient conversion of crude oil into high quality products—the goal of the setting up of a new refinery—will also cover the major part of Austrian requirements for upgraded fuels and lubes.

Crude for the Austrian refineries is derived from various areas. Up to the end of World War I, crude was mostly supplied from Galicia and Romania, whereas later supplies (after 1938) came from oil fields of the Vienna Basin, north of Vienna. Up to 1956, all oil producing wells were situated in Lower Austria, in the "Vienna Basin," whereas at this date, oil was struck in Upper Austria. An agreement between the USSR and Austria provides for a delivery of Russian crude to Austria, in order to reduce the heavy reparation load; this agreement became effective at the beginning of 1959. Finally, the characteristics of the low sulfur crudes of the Vienna Basin are presented in Table II.

USE OF NATURAL GAS

by Dr. Ing. F. Huber, Chief Engineer

With the establishment of the gas supply enterprise "NIOGAS", the delivery of natural gas to the industries and households of lower Austria was put on a commercial basis.

The project involved the delivery of about 400 million cubic meters of natural gas per year. For this it was necessary to build a high pressure pipeline system with a total length of 428 kilometers. In 1958 alone 211 kilometers were finished to supply 70 industrial plants and 20,0000 households. For homes there is a network of low pressure lines of about 285 kilometers.

High pressure spherical containers serve for assuring domestic supply in the cities in order not to disturb the safety of the network during consumption peaks.

The gas for distribution to various branches of industry is apportioned as follows: Building industry 18%, paper and pulp industry 13.3%, steel industry 12.4%, textile industry 11.2%, food industry 9.6%, power plants 9.6%, glass industry 6.2%, rubber industry 4.0%, chemical industry 3.5%, metal industry 3.1%, ceramic industry 2.9%, beverage industry 2.7%, others 3.5%.

In order to handle increasing demands for natural gas, first priority is given to such enterprises that have a nearly constant consumption. Up to the end of 1958, 80% of the 70 industrial plants were included into the supply system while the others will be supplied with natural gas by the Fall of 1959. Besides these, blast furnaces of Styria will be supplied from the southern network of NIOGAS. Distribution of natural gas in Styria is in the hands of the Steirmark-Long-Distance Gas Company. The requirement in this region is about 250 million cubic meters a year. Construction of the long distance line which has to cross the Semmering Pass (900 m) is still in progress; deliveries to the blast furnaces are scheduled for the Spring of 1959.

Gas Production in Austria in 1958

Field	Ownership	Gas Production in Cubic Meters
Associated Gas		
Muhlberg	OMV	28,534,300
Neusiedl/Zaya	OMV	4,476,200
Matzen Auersthal	OMV	295,060,800
Aderklaa	OMV	9,941,100
Gosting	OMV and Erdol produktions GmbH	1,080,500
RAG/Gaiselberg	RAG	8,678,500
Van Sickle	van Sickle	132,700
Puchkirchen	RAG	159,220
Wegscheid	RAG	9,320
Steindlberg	RAG	17,660
Non Associated Gas		
Muhlberg	OMV	76,206,600
Matzen Auersthal	OMV	80,733,300
Enzersdorf Fischamend	OMV	529,900
Zwerndorf	OMV	361,183,200
RAG/Gaiselberg	RAG	463,900
Van Sickle	van Sickle	3,051,200
Wels (Upper Austria)		27,500
	Total:	820,285,900

NATURAL GAS PRODUCTION

by Dipl. Ing. M. Hirsch, Chief of the Gas Dept of OeMV

Production of natural gas in Austria has greatly increased in recent years and is playing an important part in the production of energy used as motor fuel for self-powered vehicles. During the Russian occupation Vienna was supplied with natural gas on a continually increasing scale because petroleum production, and therefore gas production, greatly increased, and new gas fields were being discovered.

Production of natural gas rose from 70 million cubic meters in 1945 to 766 million cubic meters in 1955. However, about 240 million cubic meters of this gas per year was lost because the Russian administration made no investments of any kind, such as compressor stations, etc.

After the operations were transferred to Austrian authorities in 1955, the Austrian Mineral Oil Administration put into operation long term plans in the gas sector, including compressors of over 10,000 hp. The compressor stations at Aderklaa and Auersthal were built within a year, and this reduced the losses of gas substantially.

The Austrian Mineral Oil Administration supplies gas to only three customers. These are the city of Vienna, the NIOGAS for all consumers in lower Austria and the Steirishe Ferngas Company for all consumers in Styria.

In the natural gas field of Zwerndorf a modern recovery station, and a pipeline from here toward southern and western Austria, were built. For crossing the Danube the "Barbara Pipe Bridge" near Schechat was constructed which involved new ideas in the building of such structures.

During 1959 the Austrian Mineral Oil Administration will probably produce more than a billion cubic meters of gas, and will be the greatest gas producer in Europe.

BELGIUM

Belgian economic interest in petroleum industry development

Declining coal output and rapid industrial development promise large increases in consumption of oil and petrochemicals in Belgium

by Baron Snoy et d'Oppuers
Secretary General
Ministry for Economic Affairs

I. *Power prospects in Belgium.*

With the exception of certain short emergency periods, coal consumption in Belgium has not increased since 1913, whereas the global basic energy consumption has increased by 50%. On the other hand, coal production rose steadily until the Second World War, so that Belgium has now become an exporter.

In recent years, the nation's additional energy needs have been covered by the use of petroleum products which, in some cases, have taken over the place of expensive coal. Before the last war, the annual consumption of petroleum products was equivalent to ½ million metric tons of coal; in 1950 this figure reached 4 million tons and is now about 8 million tons.

The percentage of petroleum products in the national energy consumption has increased from 6.9% in 1948 to 20.8% in 1957. This increase is to be noted specially in the use of gas oil and fuel oils, which has doubled from 1951 to 1957, whereas gasoline consumption has increased by 43%. The electric power stations in Belgium—most of them thermic—use more and more fuel oil, pitch and gases.

As to the final net energy consumption in 1957, the part taken by petroleum products has reached 22.3% of the total. Of the fuel required for home heating 11.4% was supplied by liquid fuel and 1.7% by liquefied gases. Gas oil and fuel oil supplied 13.7% liquefied gases 0.7% of industrial energy requirements.

Before the war, Belgium was using proportionately less petroleum than most other countries but this situation is now changing very rapidly. Belgian economy is no longer based on coal, as it used to be when coal was relatively cheap and was even exported in the form of products of heavy industry. In fact, since the last war and in spite of subsidies, Belgian coal has become more expensive than that produced in other fields of the European Coal and Steel Community. This is due mainly to the fact that the increase of salaries has not been balanced by an increase of productivity as has been the case in manufacturing industries. Moreover, this situation is not compensated by a geographic protection.

As a result, Belgian coal has to meet the competition of imported coal as well as the substitution of petroleum products especially in the field of industrial coal with no specific uses.

However, it is out of the question to apply a policy of strong protectionism, which would end up in increasing the cost of energy for Belgian industry. This policy is unthinkable when we are on the eve of entering a generalized common market, when we must export 40% of our industrial production and when the cost of our labor is already heavier than in other countries.

Consequently, the current evolution will not bring about the need for an expansion of coal output with its present high cost of production, but rather it will call for a gradual modification of our coal economy. It is necessary to bring down the cost of coal production and to concentrate our efforts in favor of the better mines and of coals for which demand is increasing; coke-coal of Campine, which will not suffer from substitution in the coming years, and domestic anthracite, the production of which will long remain insufficient in European Coal and Steel Community fields.

Some may point out that coal is Belguim's only natural wealth and that it must be exploited as much as possible, even if it necessitates the help of State subsidies.

However, this country owns an even greater natural wealth; the high working capacity of its people. This manpower should be used in the best way to serve the national economy. This is not the case when it is used to produce a high cost coal which is unable to compete with foreign coal, or to manufacture half-finished products from this same expensive coal. The structure of the total energy consumption, as well as that of manufacturing industries and also the exports composition must thus be adapted to this new situation with an aim to a better use of expensive energy and labor in concentrating on the production of finshed goods of quality for the use of peoples with a high standard of living.

Belgium's traditional economic policy is strongly liberal as far as international trade is concerned. This shows up mainly in low import duties and in efforts to bring down customs barriers through arrangements such as Benelux, the European Coal and Steel Community, the Common Market, etc. However, these arrangments provide for transition periods to enable a progressive adaptation of the country's economic structure. This policy is indeed compatible with a policy of high salaries and harmonious development of the economy towards a maximum use of labor, of national resources and of a very central geographical position in Continental Europe.

II. *Belgian economic interests in the development of the petroleum industry.*

The consumption of petroleum products in Belgium now is growing at a rapid rate and will increase during the coming years. Following the general tendency of setting up petroleum refineries near consumption centers, Belgium has developed its own refineries at Belgian ports which allow easy delivery of crude. Dense population around these ports, combined with concentrated industries, a well developed road network and a high standard of living, facilitate the distribution of refined petroleum at low transportation cost.

On the other hand, the building of pipelines from Belgian ports would meet few geographical problems.

Before the war, Belgium had five small refineries producing about 293,000 metric tons per annum. The Government gave its guarantee to plans for investments and a petroleum harbor was built in Antwerp.

This policy has been continued after the war and two new refineries were built in 1951 and 1953 and the existing ones were enenlarged. Refining capacity reached 7.6 millions tons in 1958 and new extensions are planned. Moreover, a new deep water channel will soon be built in Antwerp. A project is also being studied to permit access of 65,000-ton ships in Antwerp and also to open the ports of Ghent and Zeebrugge to high tonnage ships. A petrochemical plant to process refinery gas has just been opened near Antwerp. Previously petrochemical products were imported in increasing quantities by chemical industries, so this new plant is a welcome addition to Belgian industries and is sure to find an interesting outlet on the home market as well as on the market of our Common Market neighbors.

In 1958, Belgian refineries processed 6.5 million metric tons of crude petroleum. This production corresponds approximately to our

annual consumption. However, owing to our very liberal policy with respect to the importation of refined products, foreign trade is still important, certain petroleum companies with no refineries import about three million metric tons a year of refined products, which balances the exports of domestic refineries. Home consumption is in better balance than in many other countries.

The actual storage capacity in the country was three million cubic meters at the beginning of 1959.

Gasoline and diesel oil distribution is carried out by numerous pumps set up by garages and service stations, the number of which has increased from 75 in 1951 to 1,500 in 1957.

The petroleum industry in Belgium employs about 9,800 people.

In order to meet with the rising consumption of petroleum products in Belgium—car consumption as well as industrial, chemical and home consumption—a large increase of refinery, storage and distribution facilities, as well as of the petro-chemical industry, must be planned in Belgium. The country's extremely suitable geographic position, its own balanced consumption, the absence of discrimination in crude oil purchases, property questions and financial status of refineries and distribution services, all can be attractive assets for the big world companies which would like to take advantage of Belgium's wish to extend its petroleum industry.

Baron Snoy et d'Oppuers

Belgian participation in the Fifth World Petroleum Congress

by F. P. Malschaert
Professor at the Ghent University
President of the Belgian National Committee for the Fifth World Petroleum Congress

The market for petroleum products in Belgium has developed under the influence of variable conditions which this country has encountered since the beginning of this century. Fiscal policies have sometimes favorably influenced one, sometimes another class of products. But as soon as circumstances permitted, entire freedom has always been granted to the whole market, which, generally speaking, is therefore highly competitive, with an outward appearance of abundance and facility. There is an impressive international participation in the country competing with Belgian firms, a certain number of which, in their turn, show great development abroad.

Classical prospecting methods have not succeeded in satisfying certain hopes of a national petroleum production, in spite of the relatively extensive success of the production of Holland, whose fields are situated in close proximity of our northern frontier, to the east as well as to the west.

Firedamp, a natural colliery gas, with a predominating proportion of methane, is normally produced in Belgium and made available in an industrial gas distribution network.

Belgian prospectors and oil producers have been compelled to try and find outlets for their initiative in foreign countries.

Crude oil refining on an international scale has only been introduced in Belgium since the second world war.

A petrochemical industry has developed in connection with the complex of refineries of the new petroleum port, north of Antwerp.

Provisions are being studied and carried out in order to guarantee access to the port to tankers of a very great tonnage. Many Belgian shipyards are building these ships for a number of important oil companies.

A very important Belgian petroleum group, with ramifications in the whole world, has research and control laboratories in Brussels, employing hundreds of technicians and research-workers.

On their part, the important users of petroleum products employ numerous scientific and technical personnel in their technical services and control laboratories.

Finally, the development of refineries and of the works manufacturing chemical products and the rise of the technical level of certain uses of petroleum products have led the metal fabricating industry to specialize in the planning and manufacture of equipment for the industry and the trade of petroleum and its by-products.

It is therefore no wonder that Belgian petroleum technicians are professionally interested in the 5th World Petroleum Congress. There is not a single one of those technicians who could not find a pole of attraction in one of the ten sections of this congress with its great total of 293 reports. Taking advantage of getting acquainted with other members of this congress, there is not a single one amongst them who does not hope to establish useful and agreeable relations with colleagues it would be difficult or impossible to meet elsewhere, on an equally neutral and fruitful field.

Four reports presented by Belgian nationals have been accepted by the 5th World Petroleum Congress. They deal with four entirely different subjects, namely: *Section I*: Geophysical Exploration of the Central Congo Basin and Its Interpretation, by P. Evrard, Civil mining Engineer A.I.Lg.

Section IV: Acetylene production from pyrolysis of liquid hydrocarbon feedstocks, by F. F. Braconier and P. Leroux, Ste Belge de l'Azote et des Produits Chimiques du Marly; together with W. W. Walk and G. C. Grubb, The M. W. Kellogg Company.

Section V: The Application of Gas Chromatography in the Analysis of Crude Oils, by J. Van Rysselberge, Dr. in Chemical Sciences, Purfina Research Laboratories.

Section IX: The Future Energy Requirements of the World and the Importance of Petroleum as One of the Forms of Primary Energy, by P. R. de Ryckere, Civil and Electrical Engineer A.I.G.

Eight Belgian technicians have been nominated to function as session president or vice-president, or as rapporteur.

The Belgian Council of Manufactures of equipment for all branches of the petroleum industry and trade has a stand in the Petroleum Exposition, at the Coliseum of New York, which is being conducted at the same time as the Congress.

Belgium is one of the founding members of the Permanent Council of World Petroleum Congresses. This country is represented in the Honorary Committee of the 5th World Petroleum Congress by His Excellency Mr. Silvercruys, Ambassador of Belgium in Washington, and holds one of the vice-presidencies of the congress.

I wish that the 5th World Petroleum Congress may attain a total technical, scientific and social success and that it may abundantly deserve its motto: "Petroleum Science promotes World Progress."

Its success must be a moral reward for all the members of the American Organizing Committee, for all the authors of reports and for all their collaborators, who have invested an enormous amount of work in this congress. Long live the 5th World Petroleum Congress.

A financial and industrial group for petroleum development under Belgian leadership

After a disastrous setback during World War II PETROFINA has grown at a rapid rate in recent years

by G. Van de Put
Public Relations Manager
Petrofina

THIS group's history goes back to February 25, 1920 when it was founded under the name of "Compagnie Financière Belge des Pétroles" better known under the abbreviated name of PETROFINA. The initial capital was 50 million Belgian francs; the initial purpose was buying up the control of several companies operating in Romania and whose activities covered various sectors of the oil industry. Subsequently, these acquisitions were merged into one company: the S.A. CONCORDIA, which rapidly became one of the most important concerns in the country.

As Concordia's production of crude oil increased, Petrofina persevered with its plans to become a fully integrated organization, embracing all sectors of the oil industry. With this target in view, new companies were created or major participations in existing ones purchased, thus extending group activities to the fields of exploration, production, refining, transportation and marketing.

Unfortunately, world conflict cut short the development of this progressive company and the consequences of World War II dealt a hard blow to the Petrofina Group. When hostilities came to an end, the Group had lost its assets in Romania, Bulgaria and Hungary; its refineries in France and Belgium had been destroyed; its marketing network and its all-important depots and ocean terminals no longer existed or were severely damaged and its tanker fleet had been reduced to one unit only.

Despite these difficulties, the affiliated companies of the Petrofina Group, on the very morrow of the liberation, set to work—albeit under extremely frustrating conditions—on the enormous task of reconstruction. Petrofina was not content to rebuild and repair, but was determined to carry out its development program and today, after ten years of effort, it has succeeded in creating a vast organization, which extends its activities, either directly or through its sixty affiliated companies, to all branches of the oil industry in Europe, America and Africa.

In the exploration and production sectors Petrofina has acquired an important place among Canadian producers, whilst its interests in in the U.S.A. are expanding at a regular tempo, thanks to a program of purchases, reorganization and development of existing companies. In Egypt, Petrofina holds one of the major interests in the exploitation of the Belayim and Abu Rudeis oil field. A long-term exploration program in Angola recently resulted in the founding of a new company for the exploitation of oil discoveries and the construction of a refinery.

The Group also owns various interests in exploration and production undertakings in Mexico and Venezuela.

By 1963, the Group will have doubled its refining capacity, which at the present time amounts to $7\frac{1}{2}$ million tons a year, in Belgium, Germany, Italy, the United States and Angola.

With regard to transportation, in addition to various interests in pipeline networks in Germany, Canada, the United States and the Belgian Congo, Petrofina today controls a tanker fleet corresponding to its requirements. The company owned fleet currently numbers 18 vessels, in service or in building with a total carrying capacity of 430,000 tons. Tankers charted on a long term basis represent 850,000 tons.

Petrofina sells its products (more than nine million tons in 1958) through a marketing network of 12,000 outlets located in 18 countries including those of Western Europe, Greece, the United States, Canada, Tunisia, the Belgian Congo, Angola and French Equatorial Africa.

Petrofina has its own laboratories, which study the improvement of products as well as methods of exploration, production and refining. The company has holdings in the petrochemical industry and is also interested in the manufacturing and marketing of vegetable oils, the production of asphalts, road construction work and the manufacturing of petroleum equipment.

The capital of this company, which in 1950 amounted to only 300 million francs, has grown steadily to the current figure of 3,400 million francs, by means of new share issues, the capitalization of reserves and the granting of share bonuses.

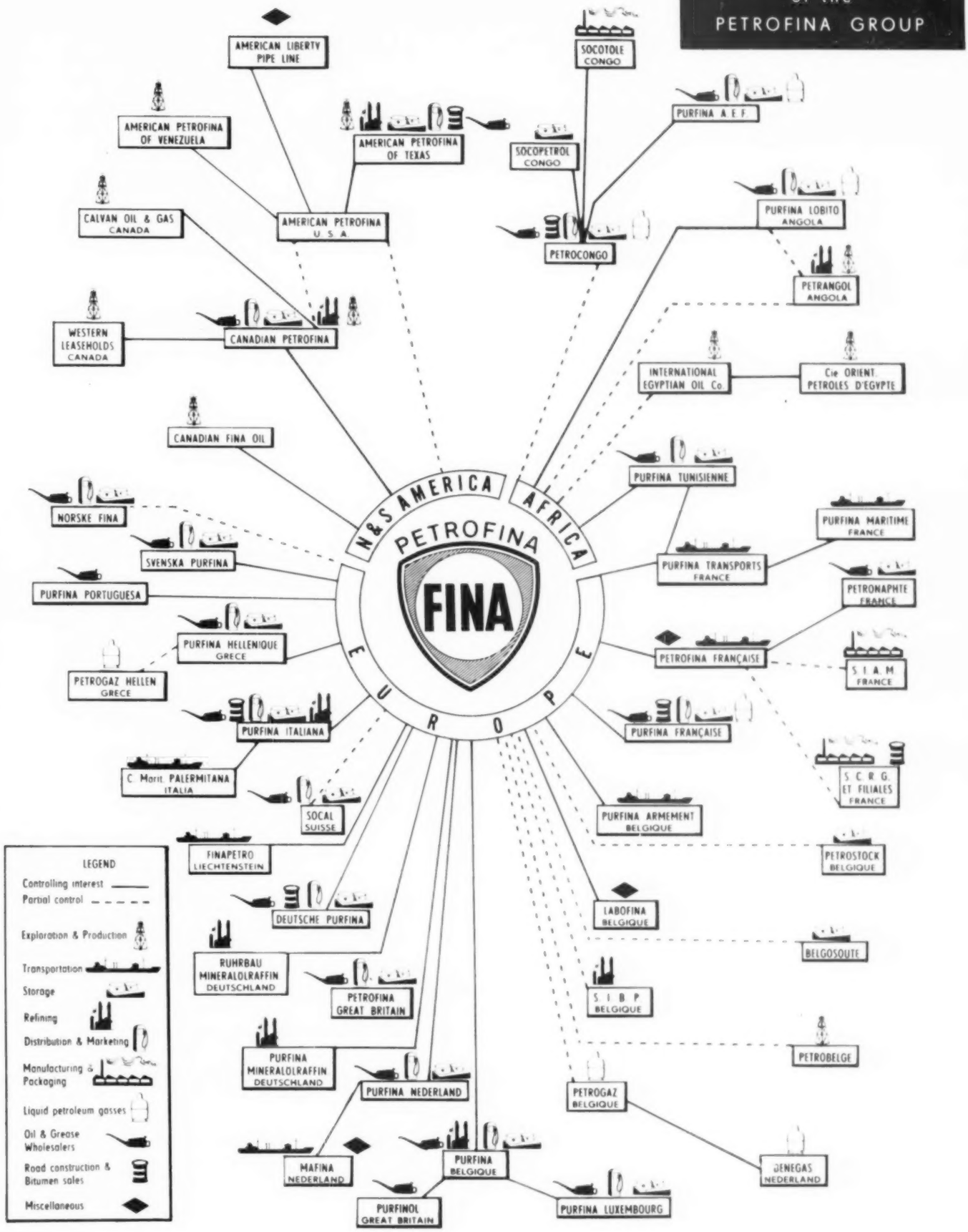
During this same period, profits have risen from 72 to 492 million francs and dividends from 58 to 382 million francs.

In addition to the organization chart which illustrates this article and which will give an idea of how Petrofina divides up risks, the following table shows where and how the Group's assets are located.

DISTRIBUTION OF GROUP'S ASSETS

		Percent
a)	**By branch:**	
	Exploration and Production	25
	Refining	25
	Transportation	12
	Marketing	36
	Miscellaneous	2
		100
b)	**Geographically:**	
	Belgium	11
	Other European Countries	33
	Africa	13
	America	33
	Fleet	10
		100

PRINCIPAL COMPANIES of the PETROFINA GROUP



Public knowledge of the oil industry promoted by "Groupement Petrolier"

Drilling rig and pumping unit on display at the 1958 World's Fair at Brussels

THE petroleum industry in Belgium has achieved a fine record of cooperation in projects for the benefit of the industry as a whole. An example is the exhibit at the exposition being held in connection with the Fifth World Petroleum Congress. Here the "Groupement Pétrolier" is displaying photographs and other material which the organization used to promote public interest in, and understanding of, the industry at the time of the 1958 World's Fair at Brussels.

To avoid dispersion of efforts—which would inevitably have been the result of separate participation by the various interests, oil companies operating in Belgium and in the Belgian Congo agreed to entrust the erection of an Oil Pavilion at the International World Fair of Brussels 1958 to the "Groupement Pétrolier", of which practically all main importers, refiners and distributors in Belgium are members.

The association worked on a strictly neutral basis and no advertising of whatever nature was permitted. The names of participating companies under the sponsorship of the Groupement were indicated on a panel in the entrance hall of the Pavilion.

The Belgian display being elaborate and very complete, oil exhibits of other countries were limited. Some countries even referred their visitors interested in oil to the Belgian Pavilion. The only noticeable display on oil outside of the Belgian Exhibit was the one presented by the U.S.S.R.

Exchange of ideas regarding erection of the Oil Pavilion were started in 1955, but when the final budget was approved, the acting committees nominated, the architect and his assistants chosen and his plans agreed upon, the scenario approved as outlined by a highly competent personality, there remained very little time to erect the building and to put on their prearranged places, the different exhibits which had to be shipped to Brussels from many parts of the world.

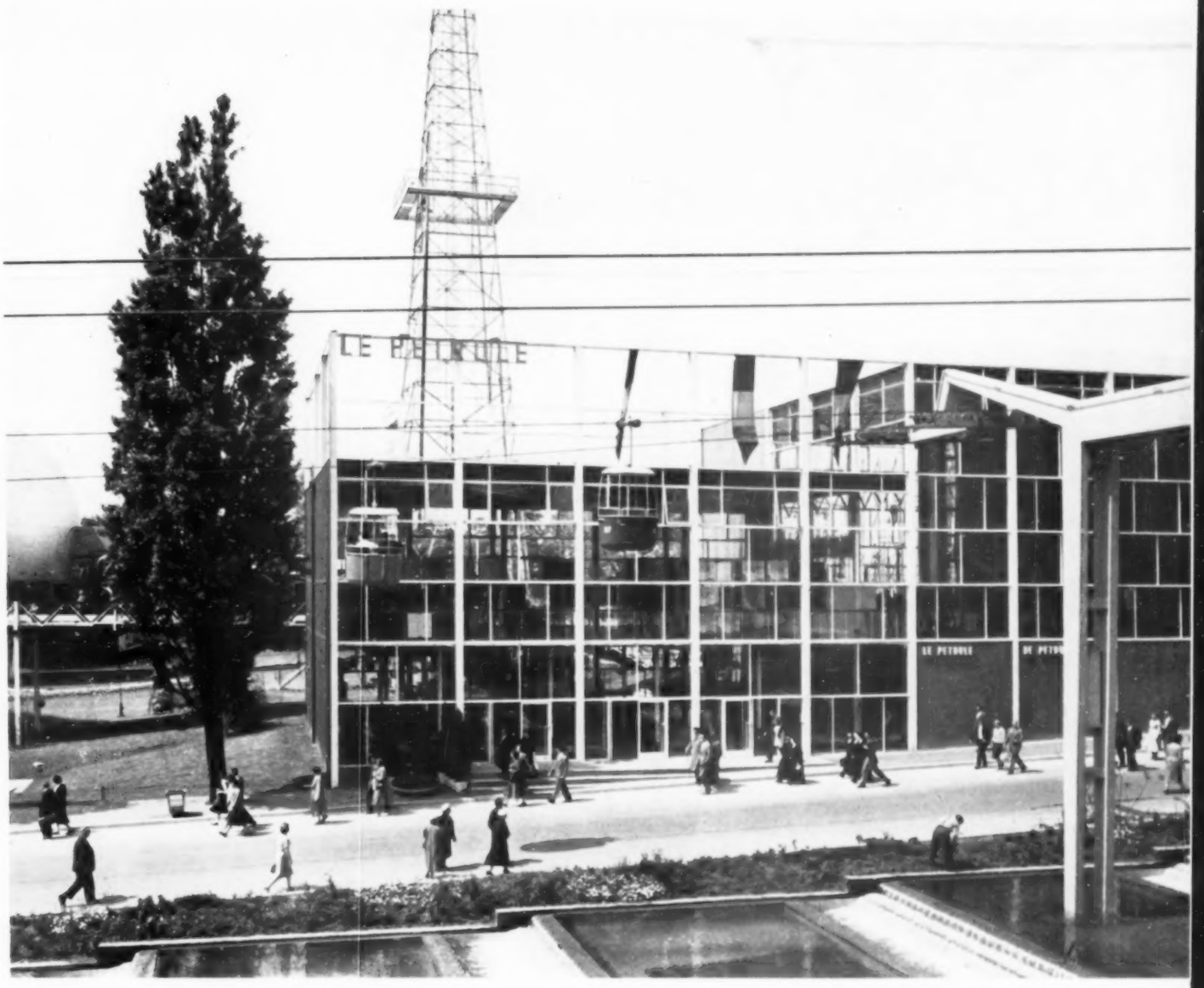
When all the thousand details pertaining to the enterprise were completed, the day of the opening, April 17th, had arrived, and the Oil Pavilion was ready to welcome its thousands of visitors who, perhaps, did not realize the amount of work, worry and preparation such display had requested.

The Petroleum Pavilion consisted mainly of one building. The main part, shelter exhibit halls, offices, meeting halls, a reception hall with bar and utilities. In addition there was a sphere representing a pressured liquid gas tank, a derrick, a Thomassen pump, a Christmastree, a planisphere and various illustrative panels. There were footbridges leading to the different parts of the Pavilion.

At two locations, loudspeakers and listening devices talking French, Flemish and English, gave general explanations to the interested individual, permitting him to better understand the exhibit.

In the first room, the visitor was given a brief introduction to oil. He was shown that the search for oil, which, as he saw, was going on in more than 100 countries, was primarily a process of defining where, deep below the earth's surface, there might be a favorable geological structure. He was told how aerial photography was employed, and tested for himself the value of stereoscopic photography. He was shown the tools which the geologist employed in his study of surface rocks and the means whereby those studies were extended to specimens of rocks obtained from below the surface. He moved across the room to a section on the geophysical techniques used to build up a picture of the unseen subsurface strata and was made aware that this was work that had to be carried out in remote and inaccessible areas of the world in jungle and swamp, mountains and desert and even beneath the surface of the sea.

In Room II, a brief introductory section looked backwards over the century of the oil industry's history, before explaining the modern techniques of rotary drilling and the new development of turbodrilling. The visitor was shown a variety of rigs, including a marine rig, and the variety of bits employed, the radioactive and electric logging techniques employed to obtain further information on the subsurface strata.



Oil pavilion at the World's Fair at Brussels

In the following section, the visitor learned the problems of conservation and economic exploitation. He saw how the search for oil and its production could bring new skills and occupations, new social and economic benefits, to previously underdeveloped countries.

The visitor left the building at a point where the oil derrick, the beam pump and the Christmas tree were clearly visible. He knew their function and purpose and was ready for the next chapter of the story—the transport of crude oil.

His path followed the logical transport sequence—pipeline from oil fields to port or refinery, tankers to refineries in other countries. He learned the advantages and disadvantages of pipelines, was shown the development of the supertanker and the importance of tankers in the world's merchant fleets. Model tankers revealed thir structure and characteristics below a dominating map of the major tanker routes.

Ahead of the visitor stood the sphere containing the refining section. Inside, his first impression was of tall columns and strange shapes—symbols of the complex of plants and installations which he found spread out before him as a scale model of a modern refinery. The displays followed an ascending path around the inside of the sphere, explaining the nature of refining and the purpose and products of the principal processes. The vital role of research in an industry as competitive as oil was shown by integrating illustrations of research work. The last stage of the sphere display sequence dealt with petroleum chemicals. Here the object was to open the visitor's eyes to the amazing range of chemicals that are produced from oil and to show how they entered every aspect of his life, industry and agriculture, public health and the home.

From the sphere, the visitor passed along displays which illustrated the distribution of oil products in a sequence from bulk supplies to small packages.

On this last stage he was aware of a vast mural ahead of him—a visual summary of the whole flow of oil from oilfields to consumers. As he approached it he was given a graphic demonstration of the place of oil today and tomorrow in the world energy picture—a demonstration that left him aware of the world's increasing dependence on oil.

The Oil Pavilion welcomed almost one million visitors, who showed a great interest in what they heard, saw and read. In developing and conducting this enterprise, the Petroleum Industry of Belgium contributed greatly to public knowledge of oil in other nations and hence its work must be considered to have been of great value to the international petroleum industry.

Petroleum and the Belgian construction and oil equipment industries

by Prof. Dr. Gaston Craen, Director of Industry and Commerce in the Ministry of Economic Affairs in Belgium

THE petroleum industry in Belgium has had a remarkable development since 1947; at first it was limited to products of primary distillation, but now it has progressed to petrochemistry.

Petroleum enterprises have not hesitated to put their confidence in Belgian constructors for the erection and equipment of the new refineries, in all matters relating to material, mechanics, and electricity.

It is in this manner that a new industry was born, comprising the creation of petroleum equipment and covering at the same time materials for the storage, fabrication and transportation of petroleum and its derivatives.

It was first of all necessary to adapt new techniques, very different from those to which our industrialists had become accustomed. Moreover, the conditions imposed by standard practice had to be followed scrupulously; construction had to be of high quality in view of the character of the product and the pressures encountered during processing. Hence, it was necessary to carry out numerous studies, and to proceed step by step cautiously in overcoming difficulties. Also it was necessary to create a corps of specialists in this new situation who could carry out faultless work that would correspond to the severe standards that were imposed.

It is now possible to affirm that the results obtained have not disappointed the oil industry, and that petroleum equipment of Belgian construction will bear comparison with foreign material.

Many sectors of the metal industry, mechanical engineering and electrical engineering, have joined in contributing to petroleum equipment, as may be shown in the following list: drilling material, storage tanks, boilers, burners, fractionating towers, reaction chambers, pressure vessels, heat exchangers, evaporators, tubes, piping, pipelines, valves, blowers, pipe fittings, compressors, carpentry, steel plates; materials for installation, electrical construction, measuring and regulating equipment, electrodes and welding materials, tank trucks, vats, jerry cans, carboys, and all kinds of hardware.

Mention also should be made of the engineering and construction firms which design and build refineries, petrochemical plants and other projects.

It goes without saying that these projects could not have been completed successfully without the spirit of cooperation that exists between the different builders. Those contracting firms which have served the international refineries, have been able to introduce great improvements.

The rise of this new activity has had a direct beneficial effect on the country as a whole. The industrialists who receive orders must call in other help and themselves become entrepreneurs and provide themselves with necessary equipment. When they have realized their profits, they distribute these to their associates or make reinvestments in the form of credits for modernization or extension.

The continual expansion of transportation activities by rail, by air, by road and by water, has created a growing demand for liquid fuel. This increase will naturally, in the long run, tend to reach a peak or ceiling if other forms of energy are applied to our boats, our locomotives, even our trucks, autos and airplanes. But we are not there, yet; we are still separated from this situation by a considerable number of years.

During all this time the petroleum industry will not cease to progress, and we will continue to obtain important benefits while maintaining a technology of high quality in following out our chosen work, which is neither wearisome or non-rewarding.

The future prospects are good for those industrialists who have taken this path.

The development of petroleum refining in Belgium is only in its infancy. As a source of energy, petroleum will have a role which will be more and more important in the immediate future.

The chemistry of the by-products will respond more and more to new techniques. Its field of application is extending day by day to the demand for more and more perfect equipment.

It is necessary for the constructors to follow these changes closely and to study modifications and improvements which become necessary for future plant construction.

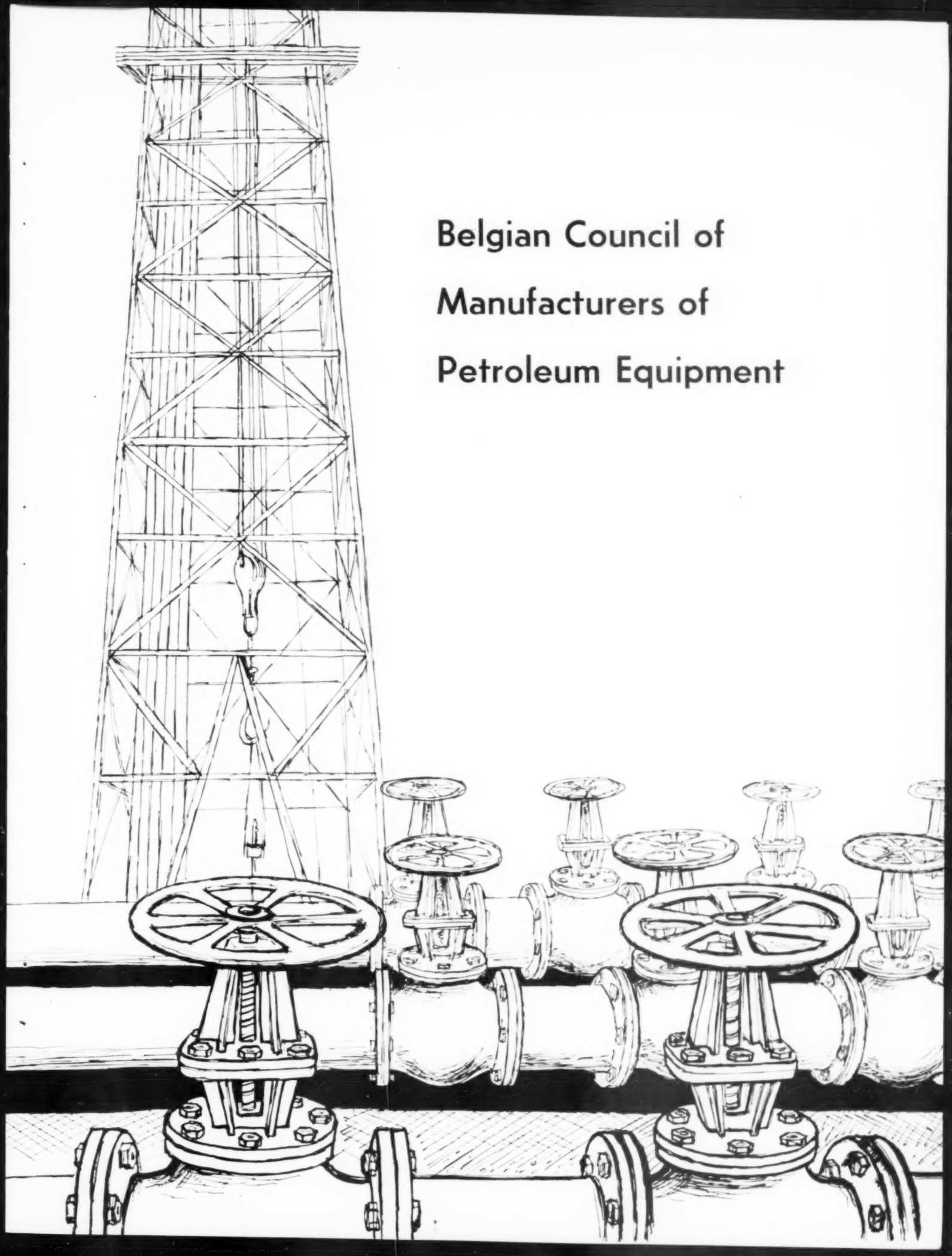
The Belgian industrialists have realized that they must establish among themselves a genuine spirit of cooperation. For this purpose they have created the Belgian Committee of Constructors of Petroleum Equipment which will undertake for them in its own name, to establish the necessary contacts.

This Committee organizes "days of study," in which the technicians, delegates from the refineries, and from the machine-building shops participate.

We may summarize the favorable consequences that result from extension of the petroleum industries on our economic development by citing these five points:

1. It has allowed the rise of a new industry.
2. It has created a spirit of cooperation among the producers and between the producers and the refineries.
3. It has contributed to the improvement of the quality of production in general.
4. It has allowed the rise of a specialization and a high quality of workmanship.
5. It has opened up new markets. We may hope that our young industries for petroleum equipment will enjoy increasing success in a prosperous world economy.

Belgian Council of Manufacturers of Petroleum Equipment



The Belgian Council of Manufacturers of Petroleum Equipment was founded in 1952 in order to organize Belgium's participation in the European Federation of Manufacturers of Petroleum Equipment

IT was at the right time that this group was created; indeed, with government prompting, two new large scale refineries had been erected at Antwerp, and these had enabled Belgian manufacturers who produced equipment of a similar nature, to obtain the know-how for the fabrication of certain material which they did not yet possess and which was essential so that they could really call themselves specialists for those supplies and compel recognition in the international market.

The Belgian industry has successfully contributed in this equipment, since the share which it has secured, includes almost the whole range of equipment, excluding only the highly specialized apparatus, the manufacture of which on a small scale was, in fact, not profitable.

Without forgetting to mention the government intervention, this remarkable result is due to the friendly cooperation of the oil companies and of their engineering offices, who have trusted the Belgian works, of which, moreover, they knew the conscience and skill, and to the efforts and dynamism of a certain number of manufacturers, who have resolutely tackled what proved to be an entirely new problem for them. When the need was felt, these manufacturers did not hesitate to look abroad for necessary engineering assistance in order to get essential guidance in this direction.

Strengthened by this experience and taking advantage of the excellent reputation they had secured through the supply of this equipment, our manufacturers then turned their attention to the world markets.

It may certainly be thought that the development of a refinery is never completed. The program of extension foreseen at the beginning is carried through in successive stages. The availability of certain refinery byproducts unfailingly entails the building of subsidiary installations to produce necessary raw materials for the chemical industry and for the manufacture of plastics. Even though they are not negligible in themselves, the possibilities offered by these domestic outlets are inadequate permanently to maintain the activity of many manufacturers and the surplus can only be disposed of in export markets. The equipment industry thus must offer its services to the engineering firms entrusted with working out the projects of installations as well as set up central groups, through which they may offer equipment.

This imperative does not dishearten the Belgian manufacturers, who always have had to try and find outlets for the surplus of their production capacity in foreign markets. In order to survive, the Belgian industry is compelled to export 40% of its manufactured products, as compensation for the essential purchases of raw materials and foodstuffs; difficulties of all kinds which impede commercial exchanges are therefore particularly well known to the Belgian firms who have to surmount them day after day.

DRILLING EQUIPMENT

Belgium is rich in coal, but deprived of oil or natural gas fields; nevertheless in connection with drilling equipment, Belgium can offer everything more or less directly connected with drilling including diamond bits. Diamonds from the Congo are used as raw material for the manufacture of these.

Cutting elements of the drilling bits consist of a metal mass in which diamond particles of a carefully chosen calibrated size are evenly distributed.

The impregnated diamond core and drilling heads have always been held in high repute because of their great strength and of their ability to work through homogeneous ground or rock of medium hardness. Latest improvements allow us to announce that there now exists an impregnated core head and drilling bit for every type of ground and for all working conditions.

Thanks to the evolution of the powder calcination technique, it is now possible to produce bits, the active part of which consists of a very thin and superficial impregnated diamond layer, which means that their price is very reasonable.

When the same technique is applied to the manufacture of separate bits, this enables us to produce diamond core heads of a very large diameter (600 mm and more) with detachable teeth, which was prohibitive when using the classical methods.

Furthermore, it should also be mentioned that interesting applications of diamond core heads and bits for turbodrilling have also been made.

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TANKS AND TUBULAR GOODS

Drill pipe. The Belgian pipe industry has been interested since 1920 in oil boring in foreign countries and more particularly in Romania. At that time, each operating company still had its own particular standards, which needed to be improved.

Efforts to obtain close cooperation between oil operators and the pipe manufacturers have been very profitable and its is precisely in the framework of this cooperation that a Belgian firm, which had been allowed for more than 30 years to affix the API monogram upon its products, has had the opportunity of supplying the first pipe to European oilfields.

A great quantity of drill pipe has been supplied since then, everywhere in the world, including North America and Latin America.

Belgium is an important steel producer, and exports 70% of its production. It has developed in a spectacular way everything connected with implementing steel products and particularly plate work.

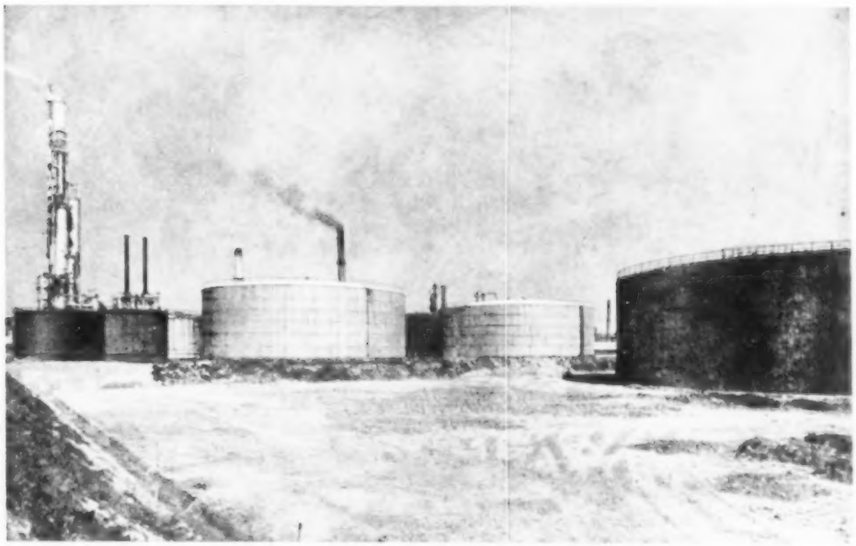
In the field of line pipe and without mentioning the regular production of seamless pipe, meeting the requirements of API specifications, the Belgian industry is equipped for the production of welded pipe of large diameters up to 36 inches and it has already supplied many important pipelines all over the world.

Tankage is also an important steel consuming sector. In order to be produced under good economic conditions, manufacturers require a heavy and very efficient equipment such as planing machines, shearing machines, oxygen cutting devices, bending machines, edge planing machines, handling devices, and a carefully planned organization in order to limit shifting and loss of time.

All these requirements have been met in the specialized Belgian works, which can be proud of having supplied their products all over the world. A certain number of them moreover have the advantage of manufacturing in accordance with American licenses.

The question of steel quality, appropriate for very thick thimble-joints particularly commands the attention of the Belgian steel manufacturers, who presented a report in this connection, at the 4th World Petroleum Congress in Rome.

ATELIERS DE CONSTRUCTION DE WILLEBROEK S.A.



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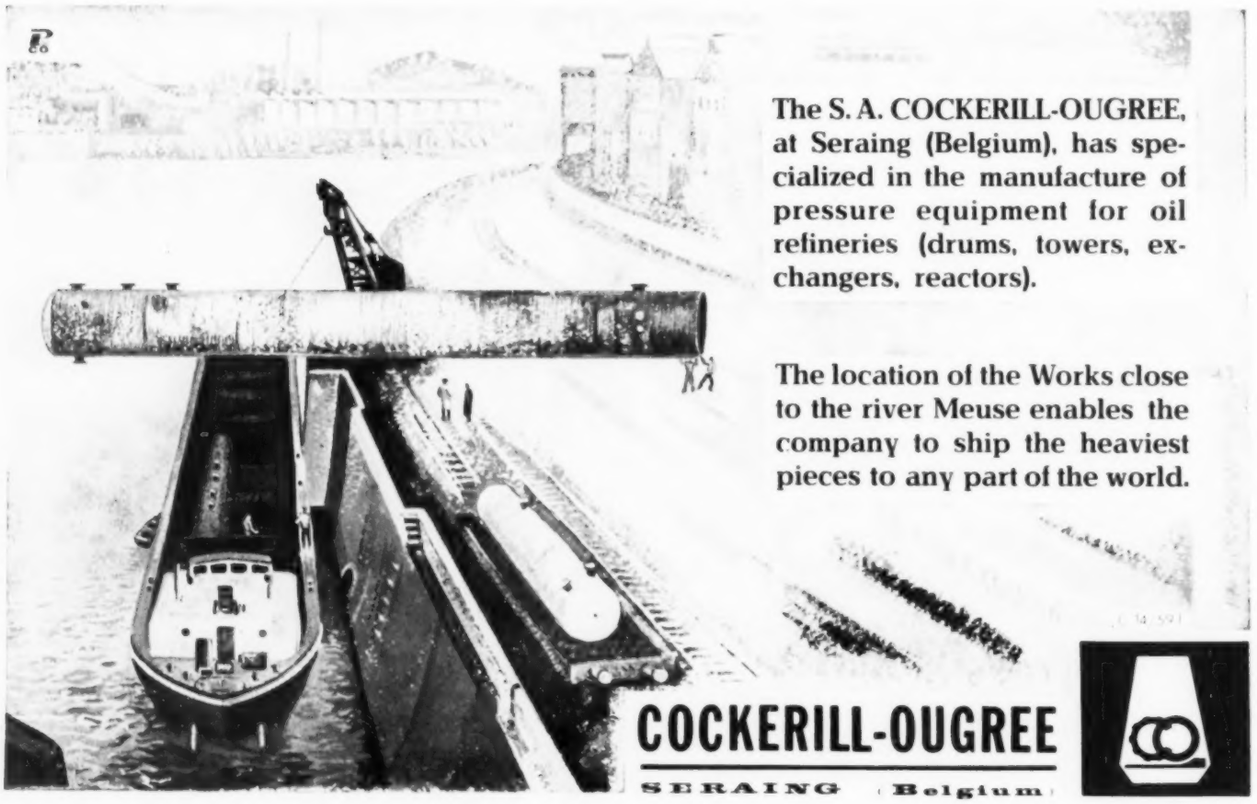


The S. A. COCKERILL-OUGREE, at Seraing (Belgium), has specialized in the manufacture of pressure equipment for oil refineries (drums, towers, exchangers, reactors).

The location of the Works close to the river Meuse enables the company to ship the heaviest pieces to any part of the world.

COCKERILL-OUGREE

SERAING (Belgium)

BOILERS
PRESSURE VESSELS
TOWERS AND
EXCHANGERS

HAVING always been at the head of progress in the field of steam generating stations—the only ones used in Belgium for the production of electricity—and furthermore, often with the cooperation of American companies of world repute, and also having had to meet the very varied requirements imposed on equipment for the chemical industry, heavy boiler manufacturers are completely ready to accept and to comply with the still somewhat stringent requirements of the petroleum industry.

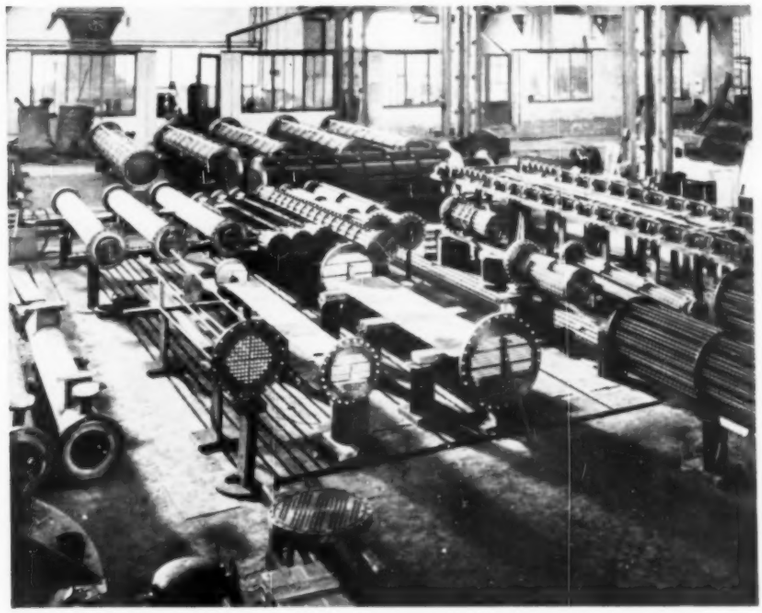
Having completely equipped their plants, improved their control installations, perfected their techniques and, in order to do so, having occasionally sent their technicians to visit American firms for information, a great number of members are in a position to supply all the heavy boiler equipment entering in an oil refinery such as boilers, fractionating towers, catalytic reaction chambers, heat exchangers, involving:

—great thicknesses;
—special steels—stainless and clad metal steels;
—non-ferrous metals—copper, monel, aluminum, etc.

They have at their disposal:

—all the tools and equipment enabling them to work on these products, to bend, to bevel and to cut them;
—installations—the most perfected welding ones: immersed arc welding, or shielded arc welding under an atmosphere of argon or Co_2, for welding at great depth;
—annealing furnaces allowing the most varied heat treatment;
—machine-tools and modern equipment ensuring interchangeability of parts of apparatus of the same type;
—special roller beading equipment, with automatic release at the required beading pressure;
—X-ray radiography and isotope radio installations and ultra-sound control installations.

ATELIERS DE CONSTRUCTION MÉCANIQUE DE TIRLEMONT



A.C.M.T. are concerned particularly with the following equipment:

Plate work: Pressure vessels of any kind, large towers and heavy processing equipment (carbon and or alloy steel)

Tubulars: Heat exchangers, evaporators, condensers, coolers, etc. all in accordance with T.E.M.A. code specifications (Lummus and customer's design)

Filter presses, bag filters, continuous rotary filters.

Specialized equipment: Vacuum pumps with liquid ring, air compressors, generating sets, refrigerating plants.

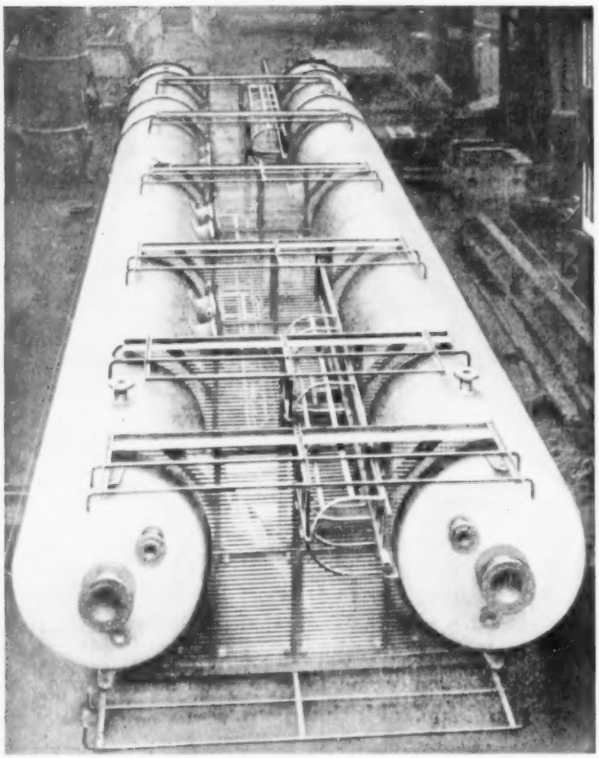
Hoisting equipment, continuous and discontinuous handling plants.

ACMT

ACMT. TIRLEMONT (BELGIUM) PHONE: 016 810.12

ATELIERS J. HANREZ S.A.

established 1857



Two distilling columns with Raschig rings, for the petroleum industry in Antwerp (Belgium), each 62' long and 67" diameter.

SPECIAL METAL DIVISION

MAIN SPECIALTIES:
special steel- and cast iron constructions for the petroleum- and chemical industries,
welded fabrications in special metals and all grades of clad steels,
pressure vessels—scrubbers—heat exchangers,
evaporation, distillation and concentration plants (termo-dinamica patents)—license for Belgium & Belgian Congo,
industrial firing and dedusting plants,
handling and conveying equipments.

First class references may be supplied on application.

41, RUE DE TRAZEGNIES
MONCEAU-SUR-SAMBRE
BELGIUM
PHONE: CHARLEROI 07 31 44 00 (5 LINES)

REFINERY EQUIPMENT

The best references which the Belgian industry can muster for this production are undoubtedly to be found in the equipment supplied to the Antwerp refineries, but other orders have been recorded and these have encouraged those who had made the first efforts along this line and that is how supplies have been shipped to India, Indonesia, South Africa and South American countries.

The handling possibilities of these works, the equipment of the transport networks, the installations at the port of Antwerp allow the shipping in Antwerp, in one single piece, of the bulkiest materials, including towers of more than 40 m of height and of a diameter of 3 m, weighing almost 100 tons.

The efforts towards modernization, pursued by our works, place them in an excellent position to ship equipment for the nuclear industry. Many orders have been received and are now being carried out. The new investment and the necessary improvements in order to guarantee the success of this most recent production, which has to comply with even more stringent specifications, will in the future, also help to produce more boiler equipment and, if need be, to improve the quality of these products or to widen their range.

Furnace construction, which is also a specialized activity requiring particular care, has been taken in hand by various manufacturers who can offer—large petroleum furnaces of the Box- or A-type;—furnaces built under American license either in accordance with the Petrochem principle, which ensures a uniform heat transfer rate along the tubes, or Selas furnaces regularly used in the petrochemical industry.

Many achievements have been recorded either in the refineries, or in kindred branches erected in Antwerp.

Within a kangaroo's bound of your refineries...

...we can serve you with a complete line of high quality equipment such as heat exchangers, fractionating columns, towers, storage tanks, pressure vessels, etc.

★

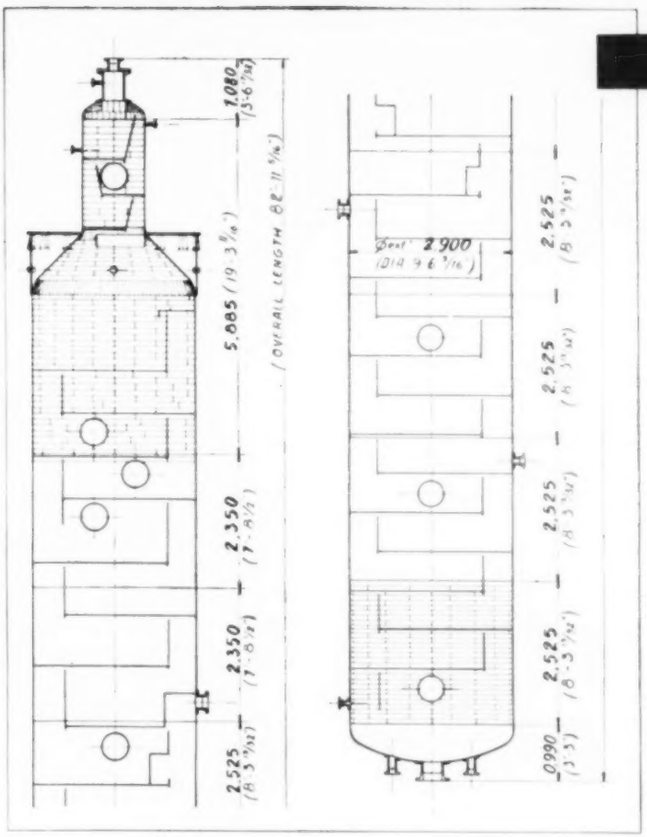
We are recognized specialists in handling all grades of carbon steel, alloy and stainless steel, nickel, cupro-nickel and aluminium alloys.

★

TEMA and ASME code for unfired pressure vessels are complied with readily.

If you are interested in saving money, in high quality and quick delivery, add our company to your bidder's list.

S.A. LES ATELIERS DE CONSTRUCTION **FRANÇOIS D'HONDT** 112-114, Rue Bara, BRUSSELS 7 – BELGIUM – Phone : (02) 21.00.76
Telegraphic adress DHONDTCUIVRE BRUSSELS



LA BRUGEOISE & NIVELLES S.A.

Vessels, heat exchangers, towers, drums and tanks of carbon steel, clad, lined and or stainless steel, for refining and storing crude oil, hydrocarbons and liquefied gases.

The opposite Crude Pipe Still Tower was manufactured in duplicate by us for ESSO STANDARD REFINERY, Antwerp and STANVAC REFINERY, Bombay.

Main dimensions: 9.6.3/16"OD—82'11.5/16"lg
1/2" nominal thickness
1/4" corrosion allowance.

Weight: 32 tons, without trays, bubble caps, down-comers, chimneys, etc.

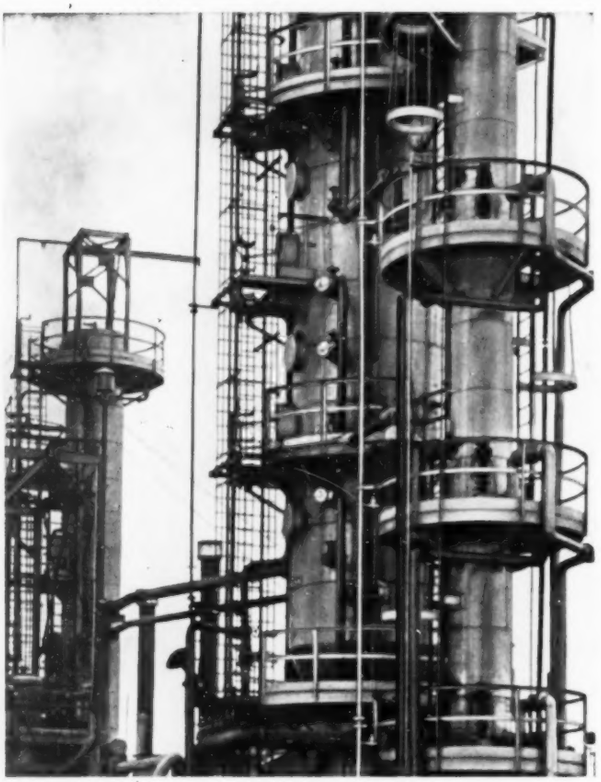
Materials:
Vessel: Carbon steel, ASTM A 285, Grade C—firebox.
Internal fittings, baffles, trays supports, bolting bars, rings, etc.: Monel metal and stainless steel.
Inside of vessel protected against corrosion by 1/8" thick welded strips:
Top part: Monel ASTM A.263, grade A, 12% cr.
Manholes and nozzles: Welding neck—ASA 150 lbs R.F.

Fabrication: API-ASME Boiler Code.

ST MICHEL-NEAR-BRUGES (BELGIUM)
050/312.01-02-03-13

S. A. TUYAUTERIES & CONSTRUCTIONS

HAINE-SAINT-PAUL (BELGIUM)



This Company extends its activity to three divisions:
a pipe preparation workshop;
a plate shop;
a workshop specially equipped for the fabrication of chains.

The Company normally employs 60 engineers, technicians and office employees, and 350 to 400 workmen.

Its pipe-work division has specialized in shop preparation and assembling on the site of high pressure and high temperature piping, and is familiar with the welding technique of Chromium-, Chromium-Molybdenum-, and Nickel-Chromium steels.

Piping of any kind and any steel alloy for:
- power plants,
- processing units,
- plant transfer lines.

Complete water softening installations (British license).
Steel structures.
Pressure vessels.
Tubular heat-exchangers, condensers, etc.
Railway tank cars.

'INE-SAINT-PAUL (BELGIUM) PHONE: 064 231.36

ERECTION WORK

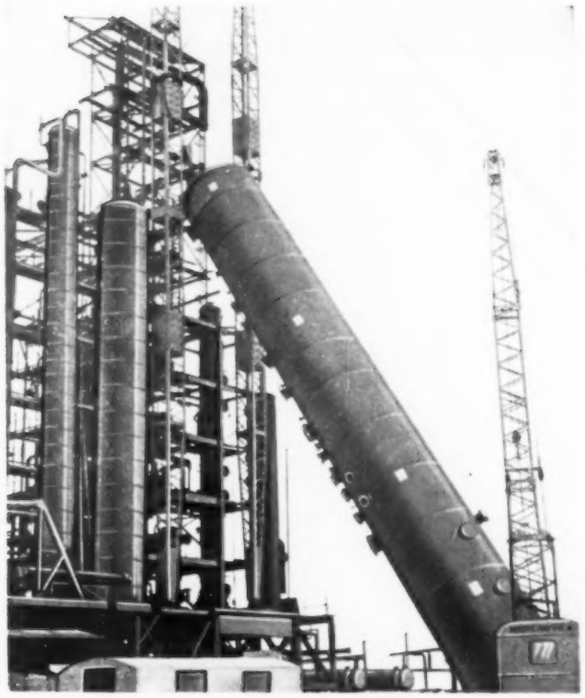
Erecting petroleum installations and laying down pipelines require very important appropriate equipment as well as experienced manpower and direction. In this field also, Belgian firms can present first class references, gathered not only when the Antwerp refineries were built, but also when equipment was supplied to the Congo and to various European countries.

PIPING

Since they constitute a vital part of steam generating stations, steam pipes need to be faultlessly manufactured. No difficulty is therefore presented at all to works accustomed to this discipline, in order to comply with the requirements imposed by the oil companies: welding under a protective flux, heat treatment, controls of all kinds are normal practice and enable them to guarantee products of the highest quality, even for jobs carried out on the site.

Furthermore, the home market is abundantly supplied with oil pipe meeting the requirements of the API specifications and bearing its monogram.

MERCANTILE MARINE ENGINEERING & GRAVING DOCKS C°, S.A.



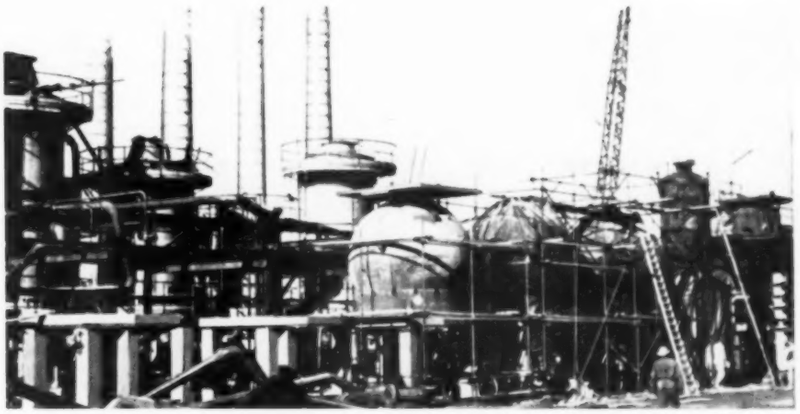
Storage tanks of any capacity. Storage tanks with self-supporting trusses for domed roofs. Floating roof tanks (Seal ring with patented variable pressure angle self-centering supports). Storage spheres. Complete tank farms. Towers, condensers, coolers, heat exchangers, etc. Structures and frameworks, etc.

Erection of a tower—diameter: 13' 2"
length: 98' 5"
weight: 70 tons.

ALL PIPEWORK. LAYING OF PIPELINES IN EUROPE AND OVERSEAS. ALL ERECTION WORK IN EUROPE AND OVERSEAS.

BASSIN CANAL W. 401, ANTWERP, BELGIUM

PHONE: 03 41.04.20 (20 LINES)



FABRICOM

BRUSSELS (BELGIUM)

Heavy and medium boiler work.
Mechanical work.
Piping.
Electrical Equipment.
Insulation.

HEAD OFFICE:
7, CANTERSTEEN—28, GALERIE RAVENSTEIN,
BRUSSELS PHONE: 02/11.23.15

WORKSHOPS:
607, AVENUE DE SCHAERBEEK,
HAREN-LEZ-BRUSSELS. PHONE: 02/51.25.11

VALVES

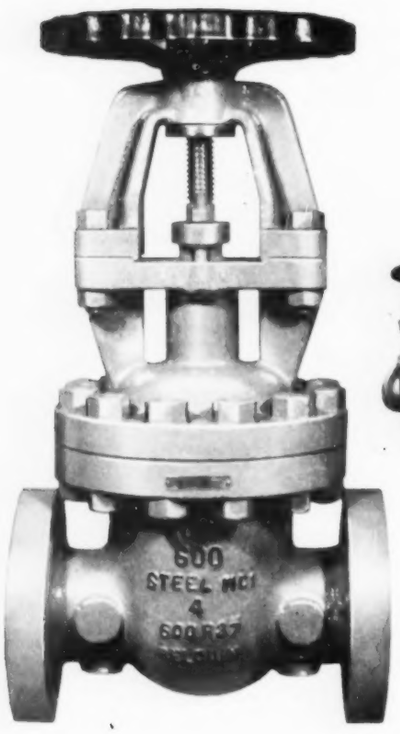
Valves are one of the most important safety factors in petroleum installations. Their manufacture must meet very strict API requirements, with which only highly specialized firms can comply. The best proof of the outstanding quality of the Belgian products in this field is again to be found in experience in Belgium and abroad. This has been obtained in connection with the supply of valves for refineries as well as for pipeline installations for classes 125 to 1500 and complying with API or ASA specifications.

Valve controls also deserve very special attention. An important part is played by remote controls, whose servomotor constitutes the brain. For more than 20 years, a Belgian firm has been specializing in the study of this problem. Practical experience which it has obtained, has enabled it to design a range of standard gears, meeting the great majority of requirements. The main characteristics of these are:

—an easy adjustment on new valves as well as on valves which have already been used;
—safe operation, independent of the age of the valve;
—torque corresponding with the optimum stress desired.

This control gear can be applied not only to valves, but also to: clack-valves, sluice-valves, throttle-valves, etc.

ROBINETTERIE NATIONALE — E. & J.-E. LEFEVRE



C.S. WEDGE GATE VALVE CLASS 600

Manufacturers of Valves and Flanges for Field and Refinery use and for Pipeline Service in accordance with A.P.I. and A.S.A. specifications (class 125 to class 1500).

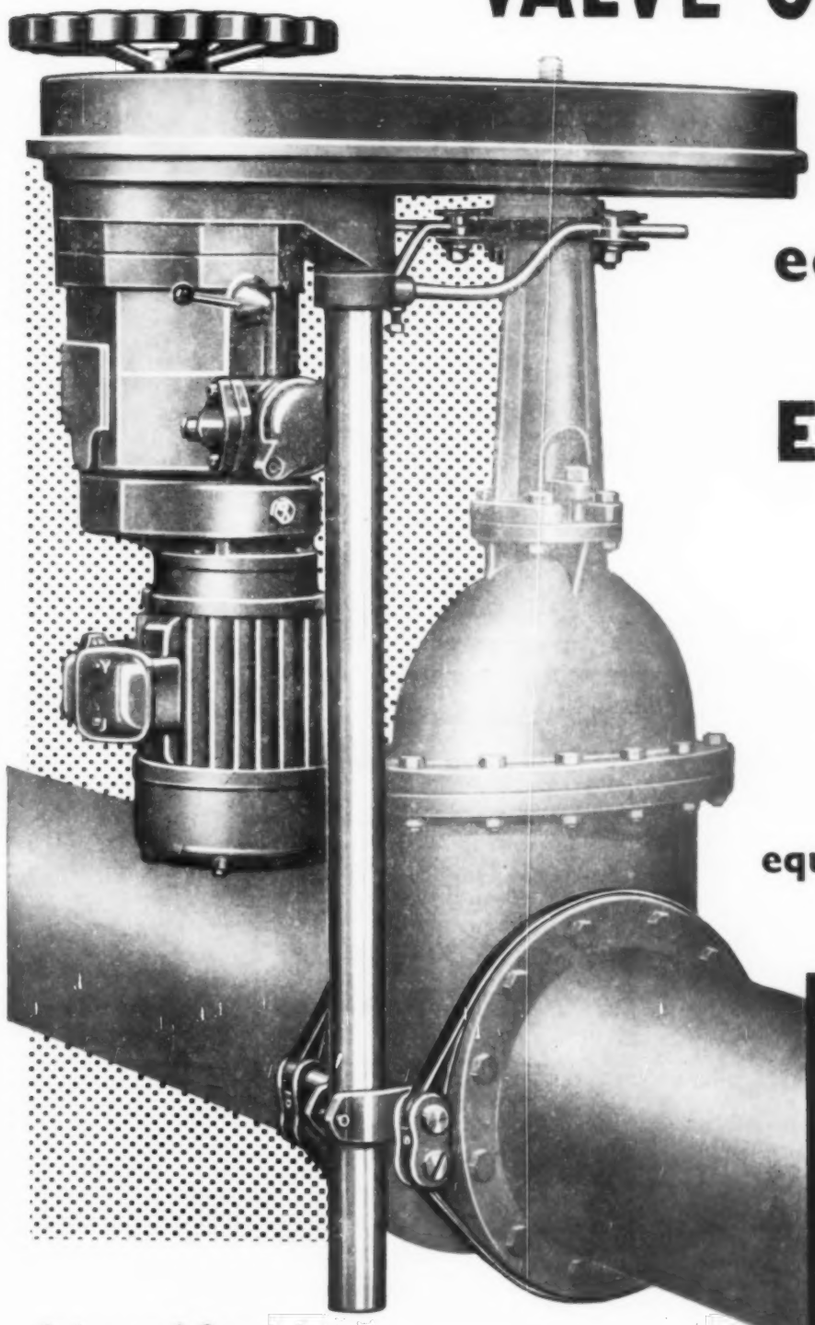
C.S. STEAM JACKETED WEDGE GATE VALVE.

Wedge Gate Valves.
Globe Valves.
Swing Check and Lift Check Valves.
Steam Jacketed Wedge Gate Valves.
Lubricated Plug Valves.
Flanges and Fittings.
Vacuum and Pressure Relief Valves.
Ball Joints.
Look Boxes.
Parts in Cast Steel.

When desired, larger size valves can also be supplied with by-pass and gearing or chainwheel.

RONA GILLY (BELGIUM) PHONE: 07/32.01.25

SADI *ELECTRIC*
VALVE OPERATORS



motorize economically new and EXISTING VALVES

Ask for literature n° 559

For over 30 years, one of the main european power transmission equipment manufacturers

Our valve operators are designed in sizes from 1/3 to 7 HP, 135 lb.in to 8670 lb.in (1.6 to 100 mkg), 3.6 to 206 R.P.M. Assembled from a series of mass produced subcomponents, they comply with the specific requirements of field operation, however strenuous they may be, and whatever the type of valve.

Sales and Servicing agencies throughout 40 countries

SOCIETE AUXILIAIRE D'INDUSTRIE SADI

4, rue des Carburants — BRUSSELS 19 — BELGIUM — CABLE : SADI-BRUSSELS

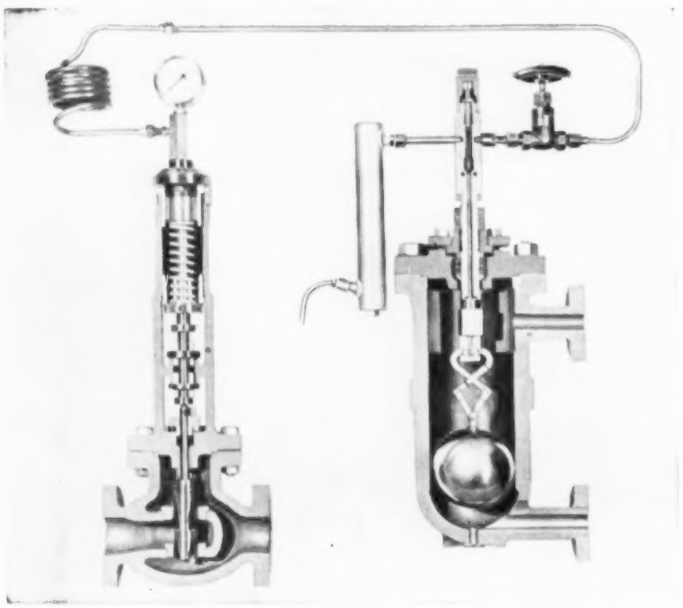
ELECTRIC AND MECHANICAL EQUIPMENT

Even though the mechanical and electric part of a refinery mainly consists of standard materials, special qualities are required therefrom. There is no difference between the requirements of refineries and those of the collieries for electric material in order to avoid any risk of spark or explosion. Having had excellent experience in the collieries for many years, Belgian firms have found it easy to adapt themselves and to manufacture equipment meeting API specifications in every way.

With regard to pumps, it has seemed advisable to try and find a solution in their production under the patronage of companies of world repute and to manufacture under license. This is particularly true for process pumps and for pumps for pipelines, which one of our main manufacturers sells regularly, in Belgium as well as on foreign markets.

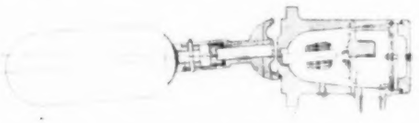
Société Technique pour l'Equipement Général des Usines

FONDÉE EN 1927



OUR MANUFACTURES AND SPECIALTIES

Servo-regulators Stegu—for pressure of 0.100 kg./cm2 to 75 kg./cm2.
Low and high water level alarm—Oil cut-off.
Stegu magnetic control and alarm—Mobrey type.
Stegu magnetic level switch—Mobrey type.



Safety valve. – Pressure regulator.
Outlet-flow regulator. – Temperature regulator.
Regulation and pressure of the return of drain-water (condensation).
Automatic greasers with multiple outlets.
All apparatus for the control of fluids in general and in particular, as well as at distance.
Tubes and sheets in Steguplastique.
Automatic sealing rings—type S.E.A.
"Oil-Seals" S.E.A.
Bestobell asbestos Department.
Jointings—Safety Pack P. 35—Asbestos clothing.

BRUXELLES I, 4, QUAI DE WILLEBROEK
PHONE: 02/17.02.27 - 17.09.27

PARIS XVIII^e, 104, BOULEVARD DE CLICHY
PHONE: ORNANO 9765 - 9810

ATELIERS DE CONSTRUCTIONS ÉLECTRIQUES DE CHARLEROI

PETROLEUM INDUSTRY EQUIPMENT.

FOR DANGER ZONES.
Flame-proof induction motors. Flame-proof switchgear: outdoor type panels—isolating switches—contactors—circuit-breakers—operating and control apparatus, etc.
Flame-proof lighting equipment: fittings for fluorescent and incandescent lighting—switches, etc.
Transformers with or without inert gas protection.
Flame-proof signalling equipment.

FOR NON DANGER ZONES.
Motors and switchgear. Substation and power-station equipment. Indoor and outdoor type Metal-Clad gear. Transformers. Fluorescent lighting equipment.

"PROCES" TYPE SPECIAL PUMPS.
Pumps for hydrocarbons, light or heavy, hot or cold products. Motor-pump units.

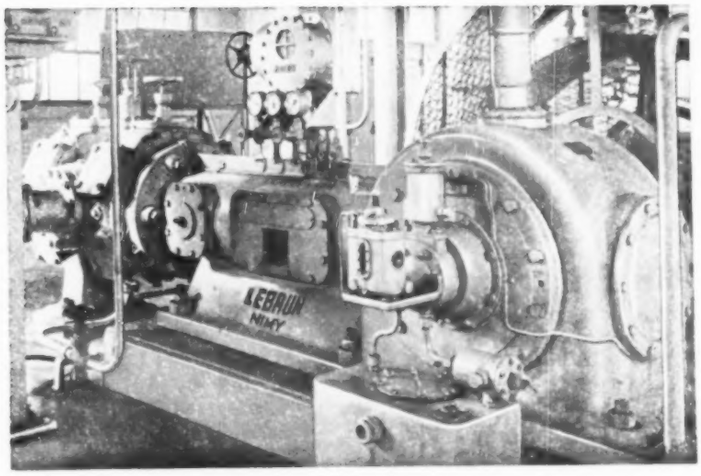
VARIOUS WATER PUMPS.
Motor-pump units.

REFERENCES ALL OVER THE WORLD: WESTERN EUROPE, MIDDLE EAST, AUSTRALIA, AFRICA.

ACEC

PHONE: 07/36.20.20

S.A. Ateliers B. LEBRUN



Reciprocating compressors (all gases—capacity from 1,000 cfm. to 10,000 cfm. for pressures up to 15,000 psi.)

Heat-exchangers (air and liquid cooled to T.E.M.A. specifications).

Industrial refrigeration (all cooling agents).

Water valves.

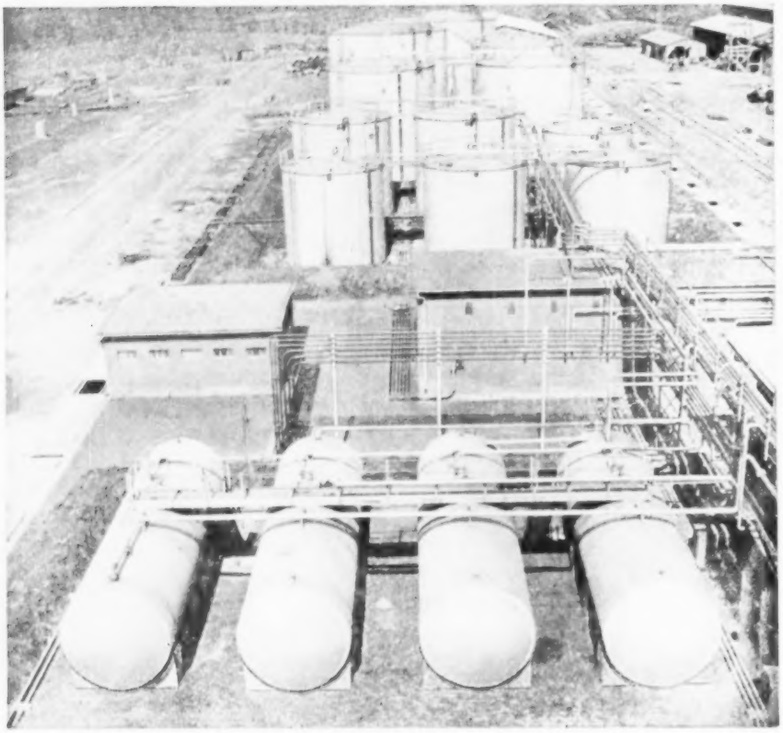
One of three horizontal double acting S02 compressors, type HD 3 R, plus one evacuating compressor, type HDOR, 100 cfm., suction 2 psia., discharge 14.7 psia., 400 rpm., Veebelt driven, 135 hp. motor.

Approved by M.W. KELLOGG, New-York (U.S.A.) and BRITISH PETROLEUM, London (England).

Inspection: LLOYD's Register of Shipping.

LEBRUN Nimy (Belgium) Phone: 065 351 51

FOURS LECOCQ ET ATELIERS DE TRAZEGNIES RÉUNIS S.A.



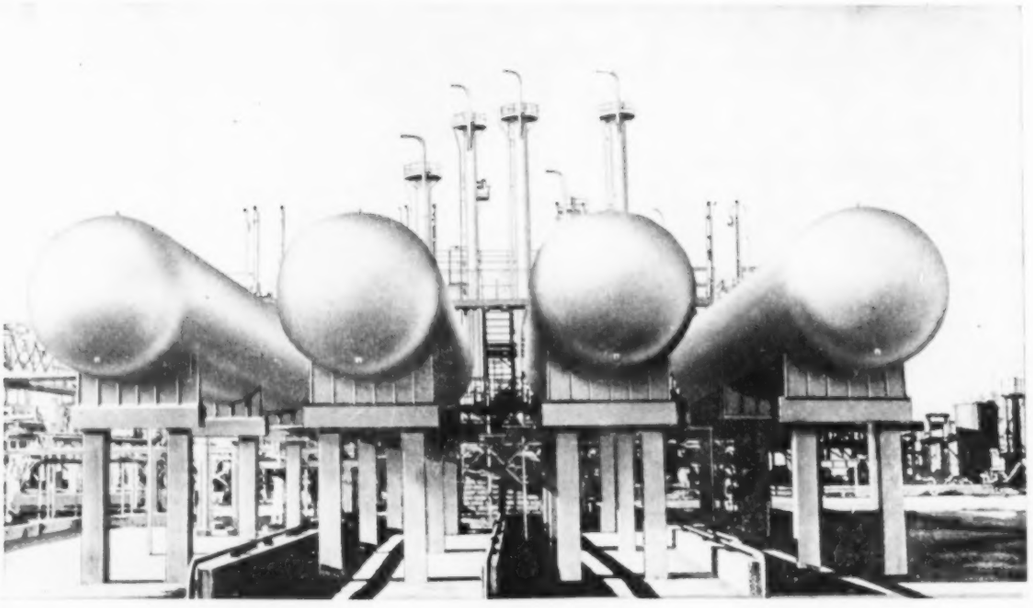
FOR YOUR FILES

DESIGN
ENGINEERING
MANUFACTURE

Production plants for:
crude oil refinery by-products
natural gas refining products
coal carbonization by-products
Storage and transport equipment
made of all materials
" Ensecote " thermoplastic linings

TRAZEGNIES-BELGIUM
Phone: 07 55.05.59

Ateliers G. & A. LEFEVRE Frères



GA L LEFEVRE

Gasholders of 150 cu.m. capacity Shell-Berre installations, Marseille, supplied by:

LEFEVRE

RANSART-BELGIUM

PHONE: CHARLEROI: 07 35.06.42 - 35.26.35 - 35.26.36

PRESSURE TANKS

Storage of finished products and particularly of gaseous products such as butane and propane is done in pressure-welded tanks, for the manufacture of which a maximum of guarantees is required. All these tank types are regularly built in Belgium.

WELDING

One of the main problems encountered in the manufacture of petroleum equipment is, without any doubt, that of welding, particularly in the case of great wall thicknesses, or of the use, either of special steels or of non-ferrous metals. A certain number of specialized firms therefore offer electrodes and welding equipment which ensure perfect results.

As a newcomer on the market can be mentioned:

—automatic machines for ledge welding of storage tanks and of the horizontal joints in two simultaneous operations; the machine moves at an adjustable speed while rolling on the hoop.

CONCLUSION

As a conclusion of this brief survey, it may be stressed that the Belgian industry can supply the greatest part of petroleum equipment, and that in this connection, it can demonstrate satisfactory experience.

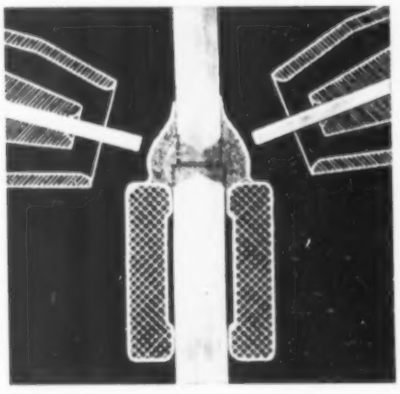
In order to promote contacts, the possibilities of the Belgian industry have been recorded in the list on page 27. Get in touch with our manufacturers, you will always find them anxious to understand your needs and to supply flawless equipment meeting your requirements in every way.

May this short article give you an idea of the effort made by the Belgian manufacturers of petroleum equipment and induce you to pay a visit to their booth at the New York Fair. Their agent on the spot shall be pleased to provide any information required and to introduce you to the Belgian manufacturers who will be in New York during this Fair.

ARCOS S.A.

ARCOSARC PROCESS
FOR STORAGE TANK WELDING

Automatic girth seam welding machine



Visible arc flux cored wire CO_2 shield

ARCOS

60, RUE DES DEUX GARES, BRUSSELS, BELGIUM

PHONE : 02/21.01.65.

BELGIAN COUNCIL OF MANUFACTURERS OF PETROLEUM EQUIPMENT

Classified list of Equipment and Services

1. General engineers
2. Boring equipment
   a) Diamond bits
   b) Boring plant
   c) Casing tubes
3. Storage tanks
4. Boilers
5. Furnaces
6. Burners
7. Fractionating towers—Reactors
8. Pressure vessels
9. Heat exchangers—Evaporators
10. Tubes
    a) Steel—seamless
    b) Copper
11. Pipings—Pipe-lines
12. Valves—Piping fittings
13. Pumps
14. Compressors
15. Diesel engines pumping units
16. Steel structures—Platforms
17. Erection work
18. Electrical equipment
19. Electrodes a. weld. equipem.
20. Measuring and control instruments
21. Tank-cars and lorries, and tanks for these
22. a) Barrels, drums, jerry cans
    b) Gas-cylinders
23. Bolts, nuts a. related products

Equipment and services offered by companies listed below (see table on page 26).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
A C E C													+										
A C M T							+	+	+														
Anglo-Belgian Cy															+								
Arcos					·														+				
Awans-François			+	+				+	+		+					+							
Bailly-Mahot				+	+		+	+	+														
Braine-le-Comte			+													+							
Brugeoise & Nivelles			+				+	+	+		+	+				+	+				+		
Chaurobel			+		+		+	+	+							+					+		
Cockerill-Ougrée			+	+	+		+	+	+		+					+							+
Combustibles Pulvérisés					+	+																	
Compteurs & Manomètres												+								+			
D'Hondt			+				+	+	+												+		
Diamant Boart		a																					
Donckers												+											
Dyle			+				+	+								+					+	b	
Ensival													+										
Fabricom			+					+	+		+					+	+	+			+		
Foraky		b											+										
Fours Lecocq			+		+		+	+	+		+	+				+					+		
Gilson																							+
Hanrez					+		+	+	+														
Heurtey					+	+			+														
Jambes-Namur			+		+			+								+	+						
Lebrun B.								+	+					+									
Lefèvre Jean E.												+											
Lefèvre frères			+				+	+	+		+	+									+		
Mercantile-Marine			+				+	+	+		+					+	+						
Meura			+	+			+	+	+												+		
Moteurs & François									+				+	+									
Nobels-Peelman			+					+			+					+	+				+		
Oisa			+					+	+		+		+								+		
Philips																			+	+			
Rivets																							+
Sadi												+											
Scapi												+											
Soudométal																			+				
Standard								+														ab	
Stégu				+		+		+				+								+			
Tôleries gantoises			+				+	+	+												+		
Tubes de la Meuse		c								a	+					+							
Tuyauteries & Constructions			+		+		+	+	+		+					+	+				+		
Union Chimique Belge	+																						
Visseries & Tréfileries Réunies										b													
Wanson				+		+																	
Willebroeck (At. de Constr.)			+				+		+		+					+	+						

BELGIAN COUNCIL OF MANUFACTURERS OF PETROLEUM EQUIPMENT

LIST OF MEMBERS

POSTAL ADDRESSES AND TELEPHONE NUMBERS.

ACEC—Ateliers de Constructions Electriques de Charleroi, S. A. Marcinelle. **Charleroi**: 36.00.20

Equipment for power-houses and transformer stations—High and low-voltage switchgears—Pumps—Electric cables and wires—Flameproof material for fluorescent lighting—Industrial Television.

A. C. M. T.—Ateliers de Construction Mecanique de Tirlemont, S. A. **Tirlemont**: 825.55

Towers—Vessels—Heat exchangers—Filters—Vacuum pumps—Refrigerating plants—Generating sets—Hoisting and handling equipment.

ANGLO BELGIAN COMPANY, S. A. 39, Widauwkaai, Ghent. **Ghent**: 23.45.41

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AWANS—S. A. Awans-François, 11, rue de la Station. Awans-Bierset. **Liege**: 63.47.14

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PETROLEUM PORT AND REFINING CENTER

A century of development

IT IS worthwhile to recall that Antwerp can claim direct industrial association with the beginnings of the oil industry in world markets. This port has played a part of importance in this field ever since 1862, i.e. nearly a century ago. In those early days in the middle of the last century and until just before the second world war the principal activity was commercial, i.e. storage and distribution, but nevertheless the first steps towards industrial activity had been taken by three firms between the two world wars. However, it was only after the second world war, under the impulse of a new international petroleum policy combined with the serious search to provide Antwerp with secure elements of long term traffic, that it was decided, in 1948, to undertake immediately development projects already off the drawing board, comprising the construction of deep water docks between the Hansa dock and the Scheld river.

In the short space of two years, the new Petroleum Harbor was constructed with a water area of 125 acres, 3,600 yards of quays and a minimum water depth of 43 feet, to receive the large tankers. To the west of the dock an area of approximately 400 acres was conceded to "Societe Industrielle Belge Des Petroles" which commenced construction of a modern refinery in March 1950 and started production in September 1951 since then the yearly capacity was raised to four million tons.

A second concession of 250 acres was granted on the east of the Petroleum Harbor to "Esso Standard Refinery" which officially began production in September 1953 and now has an annual capacity of 1,730,000 tons crude oil. Between these two refineries, on an area of 100 acres abutting on the dock a petrochemical plant has been set up which will probably start operation in the course of this year. This plant, and also a second petrochemical plant which is to be established along the 5th Harbor Dock, is directly connected to the aforementioned refineries, from which it draws the intermediate products required for its activities.

Traffic analysis

On January 1st of this year, total refining capacity reached 7.5 million tons of crude oil per year and the storage capacity of the existing 1,123 petroleum tanks totaled 2,638,000 m³. This spectacular development is clearly reflected by the statistics of petroleum traffic in this port:

SEA-BORNE INWARD PETROLEUM TRAFFIC (IN TONS)

Year	Refined Petroleum	Crude Oil	Total
1938	920.559	340.723	1.261.282
1952	1.350.650	2.176.588	3.527.238
1953	1.049.397	2.828.670	3.878.067
1954	1.037.330	3.650.315	4.677.645
1955	1.181.078	4.557.849	5.738.927
1956	1.353.212	5.060.648	6.413.860
1957	1.560.501	5.261.342	6.821.843
1958	1.300.000*	6.300.000*	7.500.000

*Estimate

A brief analysis of the petroleum traffic shows that the lion's share of unloaded petroleum originates from the Near East: Kuwait (1.8 million t.) Iran (1.8 million tons) Saudi Arabia (800,000 t.) and Lebanon (500,000 t.). Smaller quantities arrived from the U.S.A., Venezuela, Iraq, etc. As regards refined oil nearly half originates in the U.S.A., the remainder from the Dutch West Indies, Venezuela, Bahrain, and the U.K. With regard to the outward traffic of petroleum products, it should be noted that the local production is principally shipped to the continental hinterland, with the exception of bunker oil. (This latter section of the petroleum traffic fluctuates annually between 600,000 and 800,000 tons). Among the countries of destination should be noted: The Netherlands (1 million t.), Switzerland (720,000 t.), Germany (550,000 t.) and in a very small way France 1,500 t.). Besides this outward traffic there is also a quite important inward traffic originating from the Netherlands (1 million t. average): this shows clearly that both Antwerp and Rotterdam cover the same hinterland with their refineries.

Survey of facilities

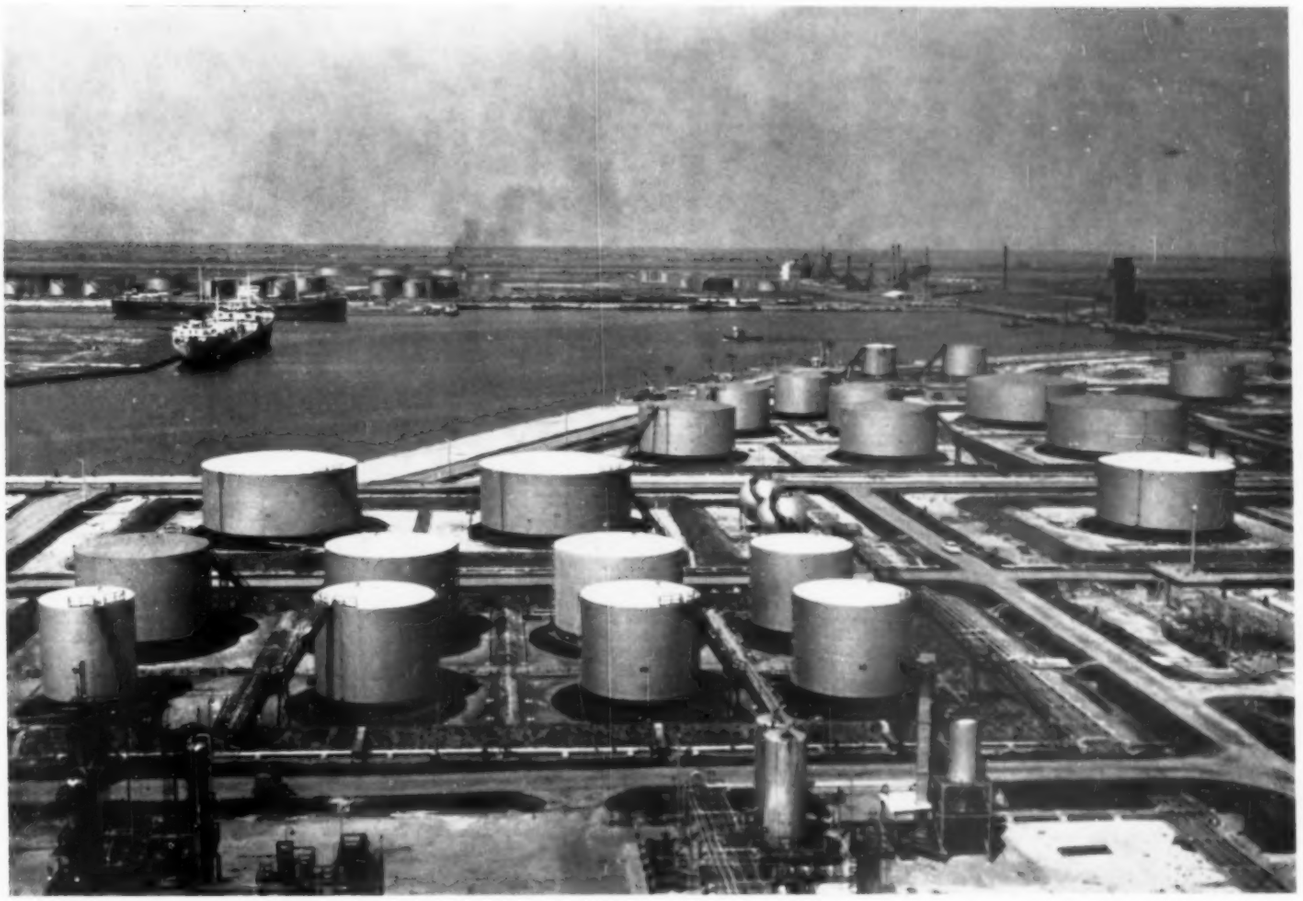
Besides the aforementioned refineries along the new Petroleum Dock, which have a total storage capacity of 1.6 million m³, the Antwerp oil installations comprise:

(a) The southern oil wharves, situated along the river Scheld at the southern end of the roads.

(b) The storage installations in the northern part of the port, at the 4th wet dock.

(c) Four medium-sized refineries in both sectors. The southern oil wharves cover an area of 180 acres. They comprise 561 tanks with a storage capacity of 822,000 m³ included the facilities of three small refineries established here since the pre-war period, and which have a refining capacity of nearly one million tons per year.

For berthing purposes of tankers and river craft the southern installations are equipped with several piers and one quay of 340 foot length. In the frame of the Ten Year Plan for Port Extension the construction of a new pier for seagoing vessels is provided for. The wharves are directly connected by numerous railroad tracks with the nearby Antwerp-Kiel shunting yard. Along the 4th Wet Dock (northern installations) are established two large storage plants, with a total capacity of 217,000 m³ and one refinery the "Belgian Petroleum Refinery" having an annual capacity of 760,000 tons and storage accommodation of 210,000 m³. The storage plants in this area are equipped for the storage and handling of animal, vegetable and mineral oil, and have both deepwater quays and excellent connections with the port's railway network. These facilities are continuously being extended, e.g. in 1958 the two plants increased their storage capacity by the construction of 56 new tanks of 77,000 m³. For 1959 the construction of 8 more tanks of 12,680 m³ capacity has been undertaken.



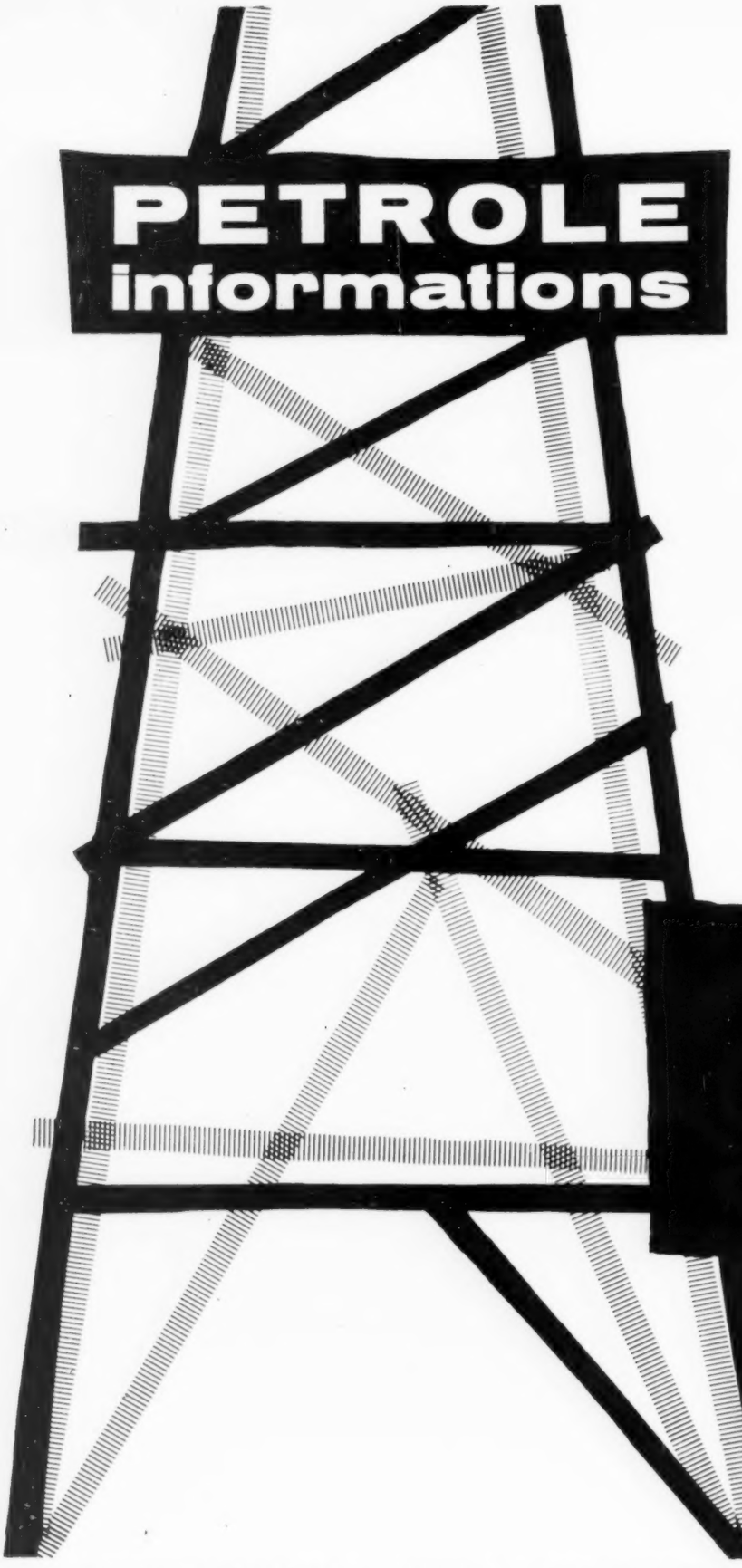
PORT OF ANTWERP–View of the new petroleum harbor and storage tanks.

A look into the future

The fact that every year large quantities of refined products must be imported from overseas, notwithstanding the expansion of the local refining industry, proves that the Western European market is far from being saturated. Hence it is quite logical that the refineries located in the port area are working out further extensions in order to cope with continuously growing demand. Besides the previously described development of storage facilities, it should be mentioned in this connection that the five refineries of Antwerp are presently carrying out a development plan for their storage tanks to the extent of some 500,000 m^3, whilst new distillation, reforming and other fabrication units are also set up to increase the refining capacity. Thanks to the 10-Year Plan (1956-1965) the development of the petroleum industry in the port of Antwerp will be easy. The construction of the 5th Harbor Dock with adjacent industrial basin, which are both scheduled to start service in 1961, will provide the local industry with some 90 acres of first class sites. These sites will be directly connected by means of pipelines, roads, etc. with the existing installations along the Petroleum Harbor. Furthermore the Canal Dock, which will be constructed in the frame of the 10-Year Plan will open large possibilities for the establishment of new refineries and storage plants, as the banks of this canal will be entirely at the disposal of new industries. Thus hundreds of acres of industrial sites will be made ready for occupation within a few years.

The second problem involved is the question whether the Scheld river can be adapted to the large size tankers of 50,000 dwt and more. While presently tankers of 38,000 dwt may safely call at Antwerp, it has been proved scientifically that vessels up to 50,000 dwt could be received on the condition that these vessels avoid the last two river sills before reaching the Antwerp docks. Hence the Belgian Government has decided to construct a new big sea lock at Zandvliet, a few miles north of the port, and through this facility the supertankers will leave the river and enter the docks via the Canal Dock. Together with the construction of the sluice some dredging works will be carried out in the river bed and an extra anchorage provided for. As to the tankers of still larger size (50,000-100,000 dwt) it is generally accepted that in order to allow these vessels to enter the port, the Scheld river ought to be normalized by damming the section between Halsoorden and Zandvliet where now too much of the hydraulic power is being lost. The project which is presently tested in the hydraulic laboratory would be executed in consecutive phases.

As a conclusion we may say that this survey of the present situation and future of the port of Antwerp with regard to petroleum traffic shows that this port occupies a predominant position and aims to maintain same by adapting both private and public facilities to the growing demands.



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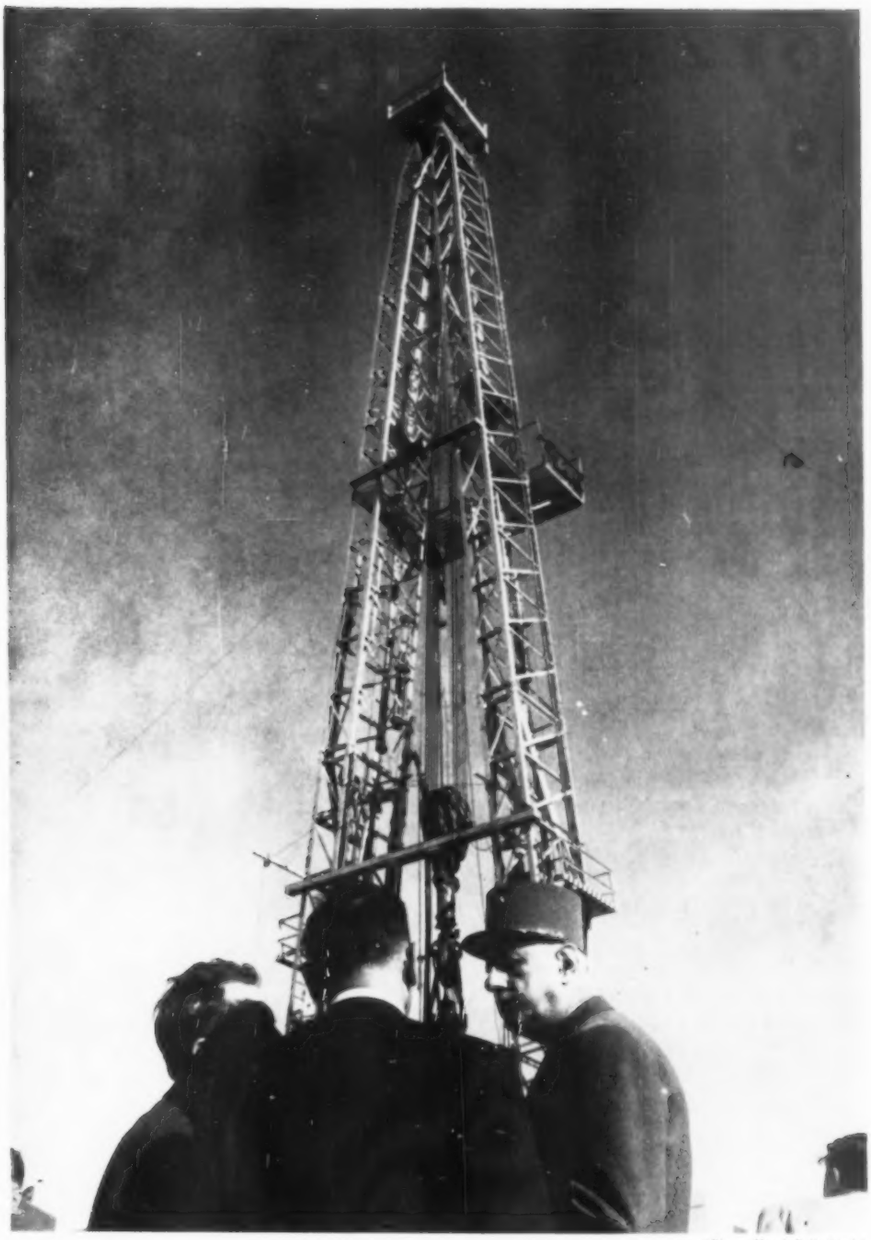

General de Gaulle during a recent visit at one of C.F.P. (A)'s drilling wells at Hassi Messaoud.

(Photo Marc Riboud Sygma)

It has happened, by a sort of contrast to which France is accustomed . . . that this great French achievement, this rise in our faith and hope has taken place in the very land where it seemed that there has never been and would never be either faith or hope for men.

C. de Gaulle.

President, Republic of France

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Oil and the French Economy

by Jean-Marcel Jeanneney
Minister of Commerce and Industry
Professor of Political Economy at the Paris University

THE original character of the oil industry leads it to play a part in modern economy which far exceeds the supply of power obtained from hydrocarbons, vital though it is.

Risk and speed are perhaps the predominant features of this industry which requires constant adaptation on the part of men, continuous modernization of techniques, everlasting imagination.

This dynamic force has been manifested in France in a most remarkable way. Benefiting by the experience of those who had preceded them in dealing with petroleum problems, the French entered the industry in a spirit of stubborn energy, determined to raise the oil economy of the French Community to a high level.

To direct the activity of a country towards an oil economy is above all an act of faith. It means confidence in a style of life in constant evolution, in a civilization which sometimes tends to oppress us, but which we should attempt to master and turn to better ends. It means the development of all the productive forces of oil, this natural source of wealth which in many respects is still a mystery. It means using our intelligence and technical knowledge to turn it to account in every possible way.

At a time when oil experts from all countries are meeting, each making available to others the most valuable of their experience, we should try to determine the grounds and meaning of our work. Such thoughts are made necessary by the importance of the results achieved and the speed with which we have obtained them.

After contributing decisively to the revival of our economy, petroleum has become one of the most efficient factors in its expansion.

Having developed its coal mining industry and its water power, our country is now entering the petroleum field. This is due to its vocation, at the same time industrial, agricultural and commercial. It is also due to its geographical situation: at the extremity of Europe, a large consumer of oil; facing the United States where this industry was born and developed; on the road from Asia to America, the route of a world flow of oil; and also on the road from Africa to Europe, now becoming a busy thoroughfare. Having twice, during two world wars when its vital forces were strained to the utmost, suffered from an almost total lack of oil, our country has fully realized the dangers of such a shortage, the import difficulties, the advantages of a regular supply and the inestimable value of a national source of petroleum. A consciousness of these problems was the starting point of our petroleum policy, built up as and when the Public Authorities and public opinion became better informed, the industry gained strength and vigor and technical progress and political and financial opportunities permitted new achievements.

The period between the two wars had already been marked by considerable success. A body of legislative measures and regulations supplementing diplomatic agreements gave access to the oil fields of the Middle East. We built a fleet of tankers, and established the first European refining industry, thus stabilizing our supplies and the organization of the French market.

While it is true that the legacy of the second world war was but ruins and devastation and that after the Liberation we had to start from rock bottom, we had the recollection of valuable teaching, and post-war imperatives were absolutely clear:

Without oil there could be no economic and social revival. A modern country consumes energy, and France, like the whole of Europe, needed an immediate and massive supply of power which neither black nor white coal could furnish with requisite speed. Gasoline and other fuels derived from petroleum contributed decisively to the success of the post war work of clearing away the debris, reconstructing, reviving transportation, re-establishing trade, modernizing industry and agriculture and raising the standard of living.

Without international collaboration there would be no petroleum. While it was important to confirm the rights of the French Company which was associated with international producers in the Middle East, re-establishment of the regular currents of supply also necessitated the renewal of commercial relations with the Anglo-Saxon groups, our traditional suppliers in the past, and after the war, practically the only ones in the new western world.

The cost of our imports had to be reduced and the foundations laid for a modern petroleum industry. For the cost of petroleum in foreign currency is less when it can be shipped under the national flag. The refining industry also saves foreign currency by avoiding the importation of finished products which cost more than crude oil. National manufacture of equipment for the petroleum industry further lightens the burden of imports. Finally, as soon as production reaches international quality, access can be gained to foreign markets and receipts from sales can be deducted from the cost of purchases.

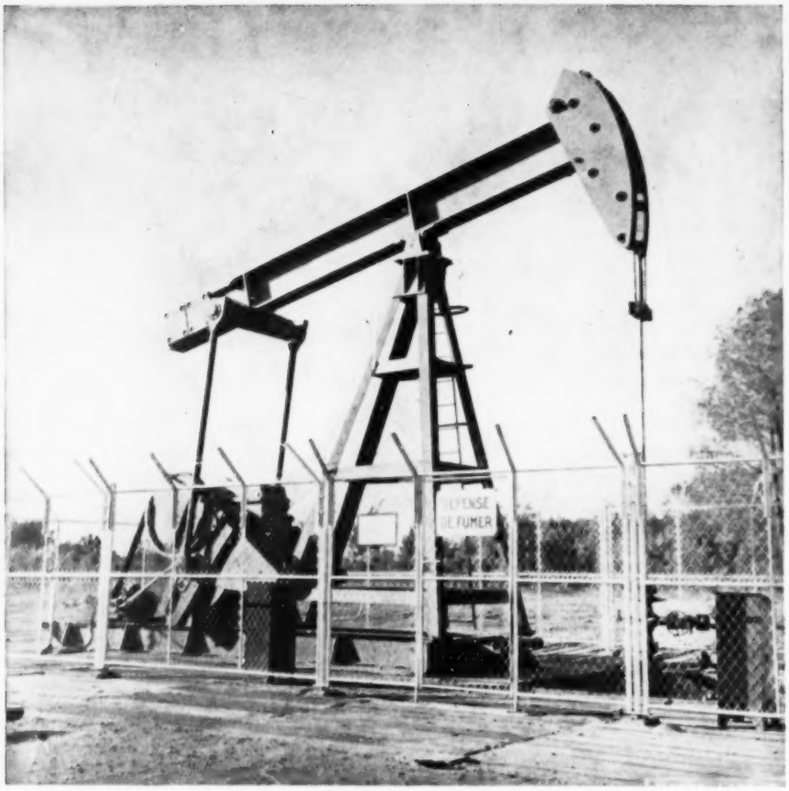
The industry also needed managerial and engineering staff, specialists capable first of understanding and applying techniques developed abroad, and then be able to improve them, to patent their own inventions and discoveries and contribute themselves to the progress of the industry.

National production safeguarding our security had to be developed. For rights acquired in foreign deposits, the flows of supplies differing according to their geographic sources, and multiplicity of suppliers are uncertain means of reaching the constant aim, reliable and regular supply. But there could be no French oil without considerable and initially hazardous exploration; and no prospecting or production without a legislative framework adapted to the industry's working conditions, guiding its efforts and ensuring continuity, sharing of profits between the operator and the public authority who granted the license.

Such were the prospects facing France at the time when, in accordance with former plans, she proceeded to reconstruct and modernize her distribution network, her fleet of tankers, her refining industry and technical schools, and the conditions under which she was led to enter upon the decisive phase of her petroleum policy by prospecting the extensive sedimentary deposits in the franc area.

Today the results achieved by France in the matter of oil are exceptionally outstanding. The oil consumption of the French Community, now 30 million tons per annum, has more than doubled since 1950 and is six times that of 1945. Constantly enlarged in proportion to the requirements of the entire franc area, our refineries supply practically all the products consumed and also work for the export market.

(Continued on page 31)



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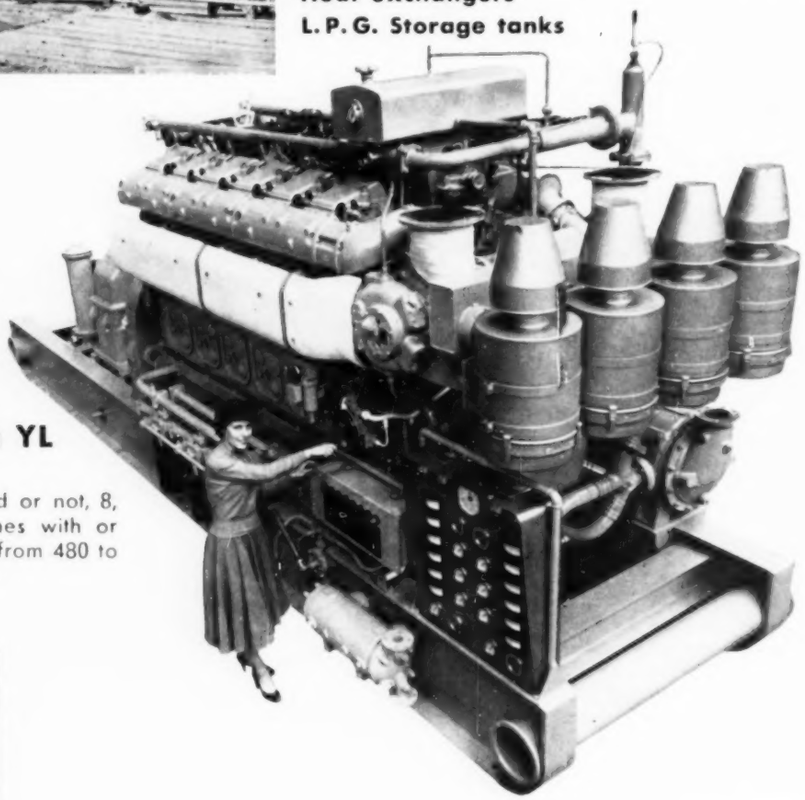

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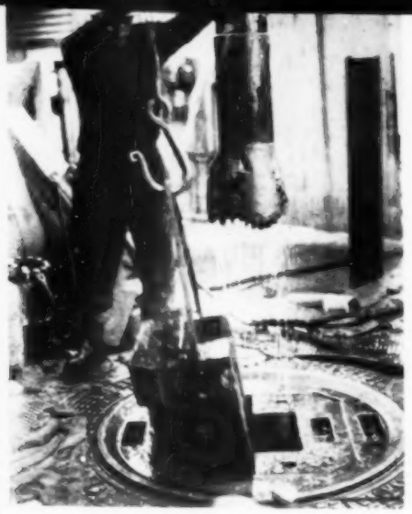


La Chambre Syndicale

The professional association of the oil and natural gas prospecting and production industry

by **Henri Ballande**
President of the Chambre Syndicale de la Recherche du Pétrole

In France, as in many other countries of the Western world, most undertakings in the various branches of industry are associated in trade organizations whose aims are of an economic and social character, and which are generally known as "Chambres and Syndicales." Thus practically the whole French petroleum industry is grouped in a Union which before the war included, in particular, a Chambre Syndicale of the refining industry and a Chambre Syndicale of the distribution branch. The Chambre Syndicale de la Recherche et de la Production is a more recent institution, having only been in existence for ten years, although the activities it represents are of much longer standing in France.

The Chambre Syndicale is essentially concerned with the prospecting and production industry of the French Community. Its active members are undertakings, of whatever form, in possession of prospecting permits and operating licenses in the Community Territories. They include state establishments, subsidiaries of large international companies, private companies, or "mixed economy" companies, i.e., companies in which the state holds an interest. It also includes as corresponding members, geophysical or drilling companies and financing organizations whose object is limited to prospecting for oil and its production.

Now, a profession or trade consists above all of men and social questions are the foremost sphere of activity of a trade organization. Without attempting in any way to take the place of the firms which carry the fundamental responsibility in this field, it is the task of the Chambre Syndicale to define the social policy of the profession according to the directives received from its members, and to apply it in accordance with their instructions. It keeps in contact with the trade unions concerned and discusses all topical questions with them, for instance the status of the staff and labor force regulations governing pay, provident institutions. On the other hand, it is the duty of the Chambre Syndicale to keep informed of all labor and social security legislation, to represent the trade with the public authorities when such legislation is being established, to act as a factor of harmony in the application of the legislation by its member companies.

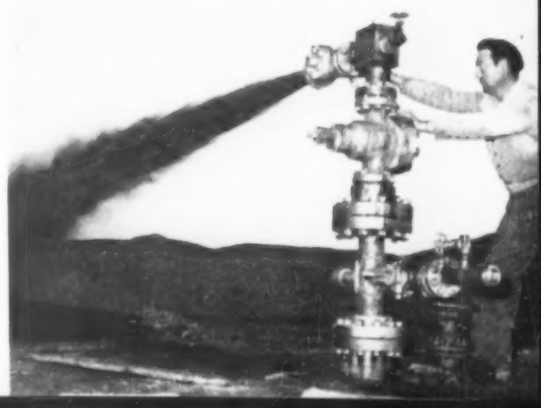
A profession is a community of interests. It is the duty of the Chambre Syndicate to maintain this representation in dealings with the public authorities, the Ministry of Industry and Commerce, the Bureau de Recherches de Pétrole, again on the instructions of its members, whenever laws or regulations of an economic, juridical or fiscal order, of interest to the prospecting and production industry, are being considered. And here again the Chambre Syndicale must exert its influence as a factor of harmony when these legislative measures are applied by its member bodies.

Representing the profession on other levels, in particular with the general public, is another of the responsibilities of the Chambre Syndicale. By keeping in contact with the press, by circulating articles and pamphlets, it devotes itself to informing public opinion objectively of the life of the industry, its aims, its needs, its problems. It also attaches itself to correcting opinions which may have been wrongly or hastily formed. And it endeavors to give efficient help and guidance to all members of the general public who frequently call on it for vocational advice and with requests for employment.

A profession is a trade or craft, that is to say, a technique or a body of techniques, and those connected with discovering and producing oil are exceptionally diversified. The relations existing among the men engaged in this branch of industry must be kept alive and bonds strengthened, to the benefit of the industry, productivity and progress. For this purpose, the Technical Committee of the Chambre Syndicale groups the technicians and engineers of its member companies in specialized commissions and maintains close relations with the Institut Français du Pétrole. The activity of this committee consists of technical organizations, study, in improving methods on the professional level by rationalization of processes, standardization of equipment and documents, the establishment of unified nomenclatures, standard specifications, etc.

Such are, briefly described, the characteristic features and the scope of activity of the Chambre Syndicale de la Recherche et de la Production. The industry it represents is brimming over with vitality, its achievements in its fifteen years of expansion are of a very high order. And its spirit of co-operation and professional solidarity is undoubtedly one of the main springs of its success.

High pressures are encountered in Sahara wells.



The contribution of The Institut Francais du Petrole to the expansion of the petroleum industry in France and throughout the world

by René Navarre
President of the French National Committee for the 5th World Oil Congress
President of the Institut Français du Pétrole

WHEN France began to reconstruct her economy after the liberation, the government consistently gave planning priority to the improvement of the country's resources in energy.

The energy available at that time to French workers was only equivalent to one-fifth of that provided for their colleagues in other highly industrialized countries. And to ensure even this small supply meant raising the production of French coal mines to its highest possible ceiling, and developing all sites where hydroelectric energy could be generated efficiently.

Relatively speaking, our availabilities of petroleum products also represented only about half our total resources in energy, even allowing for the largest contribution to be expected from French interests in certain foreign producing companies.

Under these conditions, the production of oil by France herself was the only possible means of remedying the serious lack of mechanization which prevented her workers from improving their mediocre productivity and forced her to attempt, unsuccessfully as a matter of fact, to overcome this state of affairs by assuming the crushing burden of importing coal and crude oil. Unfortunately, the French petroleum situation was extremely unfavorable in those early days.

Before the war, refining was the only branch of the petroleum industry in which any great effort had been made. Seventy-five per cent of our works had been destroyed by acts of war, when their capacity should have been quadrupled at the very least to meet the new demands. New processs, due to progress made during the war years, called for new plants to adapt the manufacture of conventional refinery products to the requirements of modern industry. And in the field of petrochemistry we had to start from rock bottom.

Practically nowhere in our home and overseas territories was there any production of crude oil capable of meeting our needs. Isolated initiatives had been disappointing. Authoritative French and foreign literature on the subject had accumulated data showing that we had little chance of success. And yet these are the foundations on which French achievements in the field of petroleum have been built up to such an extent that in the near future:

The production of our oilfields will substantially exceed the domestic demands of our economy;

Our natural gas production will bring about radical changes in the basic energy used by most of our industries and probably also those of neighboring countries;

Our factories will form a marvellous modern structure using original processes and adapted to the manufacture of the latest products.

Numerous decisions of an administrative and financial order have contributed to this expansion, giving it a novel and particularly favorable legal framework.

A large number of industrial undertakings of the most varied structure have been associated in the research and development work done by the refining industry.

One of the most striking steps has been to entrust a professional establishment, the Institut Français du Pétrole, with teaching and research activities for the account of the official bodies responsible for this great collective effort. This task has been faithfully carried out by the Institut Français du Pétrole ever since its inception, and is clearly defined in its statutes as follows:

The Institute has a three-fold mission in the petroleum field.

1. Initiation or execution of studies and research presenting an interest for the development in France of scientific knowledge and of industrial techniques;

2. Formation of engineers and foremen capable of participating in the development, diffusion and effective application of new ideas;

3. Documentation of government, industry and technicians themselves on new scientific knowledge and industrial techniques of interest to the national economy.

To carry out these various tasks the Institute Français du Pétrole developed its laboratories, research and designing and engineering departments and schools.

The laboratories have had systematic recourse to fundamental studies to ensure efficiency. Two particular cases illustrate this general trend.

In Geology, a special effort was made to develop general methods of sedimentology to discover fossil traces left in sedimentary basins by the many phenomena which caused or accompanied the formation of a deposit, whether these phenomena related to the elaboration of storage rocks, reservoirs or overlying strata, or to the building up and subsequent evolution of hydrocarbons.

In the field of refining and petrochemistry, original solutions were sought in the fundamental study of chemical reactions, considered to be decisive factors in the processing of crude and its by-products.

The Institut Français du Pétrole has also adopted a second essential principle, which consists in putting its research work to the test at a very early stage by applying its results to concrete cases. This led to the organization of the various divisions of the institute which work directly for account of the industry to aid it in solving the actual problems with which it is faced.

Thus it is that the Bureau of Geological Studies has been led to make very extensive geological pre-reconnaissance surveys with a view to determining the most worthwhile objectives to be aimed at and the most efficient specific methods to be used in the vast areas it has been asked to investigate (620,000 sq. km).

The same department has also carried out numerous contracts covering the analysis and reassessment of the results of prospecting (215,000 sq. km) for the account of various companies at certain stages of their work. Some of these reports have been helpful in bringing out very fruitful new assumptions.

Certain services have been developed in this connection, among them a well equipped and highly efficient Photogeology Bureau (1,500,000 sq. km of photogeological maps).

In the same way, side by side with the laboratories for fundamental chemistry, extensive services have been organized for the development of industrial processes in which Industry evinces interest. These services include all the usual research facilities available in conventional chemical engineering and also pilot plants.

A subsidiary engineering company (Compagnie Française d'Etudes et de Construction TECHNIP) offers the same services as conventional companies of this type and, in addition, takes part in the industrial finalization of processes.

The same work of fundamental and applied research has been developed in geophysics and production, and within the near future will be developed in drilling

(Continued on page 42)

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Bureau de Recherches de Petrole

by Yves Delavesne
Managing Director of the Bureau de Recherches du Pétrole

Results and Prospects

THE Bureau de Recherches de Pétroles was instituted on October 12, 1945 by the provisional government of the French Republic headed by General de Gaulle. This organization was given the task of preparing and directing a general prospecting program covering both metropolitan France and the French Union.

In 1960, scarcely fifteen years after the impetus given by the public authorities, France and the French Community countries will be among the ten foremost world producers of natural gas and oil.

Lacq, Parentis, Edjeleh, Hassi-Messaoud, Hassi R'Mel, Pointe Clairette, all these now familiar names, represent the discovery of recoverable reserves amounting to 1,000 billion m^3 of gas and 700 million tons of oil, blaze the trail to success and, in addition, will make France the third world producer of sulfur. Such success is not due to chance, it is the happy result of persevering efforts carried on according to a coherent plan served by powerful means.

According to the programs and with the means proposed by the Bureau de Recherches de Pétrole, 800 billion francs will have been invested between 1945 and 1960, both for prospecting and for development, and processing and transport structures; more than 4 million meters will have been drilled on the 1,500,000 km^2 (576,900 sq. miles) covered by the permits granted, thanks to equipment which will number some 140 items by the end of this year.

On December 31, 1958, 42 companies held mining licenses (exclusive prospecting permits and concessions) in France or member countries of the French Community, either individually—or jointly with others.

Out of these 42 prospecting and mining companies,

24 are controlled exclusively by French interests,

5 are controlled in majority by French interests,

4 are controlled in equal shares by French and foreign interests,

3 are controlled in a majority by foreign interests,

6 are controlled exclusively by foreign interests.

The government is interested in 26 of these 42 companies and has a majority holding in 15.

Of the three companies controlled in majority by foreign interests, two are holders of mining licenses, with a Government interest, and one is the holder of mining licenses in the form of an association in which the French partner holds a majority interest.

The six companies controlled exclusively by foreign interests hold mining licenses in the form of associations with French partners.

While these figures show the volume of activity, they only give an incomplete idea of the sum of simultaneous efforts which were required for training the personnel, manufacturing the necessary equipment on French territory, making a geologic survey of all areas theoretically considered as oil-bearing, organizing and financing the prospecting Companies.

By the end of 1959 the Ecole Nationale Supérieure du Pétrole, the principal training school, will have made 563 geological and geophysical engineers, 395 drilling and production engineers and 703 drilling technicians available to companies or contractors.

As regards plant, French industry is now in a position to supply by far the greater part of what is necessary and also to export equipment. It has created its own designs, and its design engineering offices have also developed original equipment, such as drilling turbines.

A first exploration of a large part of the "French Union", including several oil fields in metropolitan France, and the general organization of the prospecting industry have been carried out by the Bureau de Recherches de Pétrole. In doing so it had recourse to a great extent to the "mixed economy" formula, in which government initiative is relieved, whenever possible, by private endeavour, while continuing to exert its necessary stimulating and controlling action in the general interest.

The positive task thus achieved was planned and organized by France, but in a real spirit of cooperation and association with national, as well as with foreign and international groups. This attitude was definitely manifested from the very beginning of the venture, and not determined according to changes which may have taken place due to any particular economic contingency or fluctuating policy.

While the public authorities initiated this oil policy which is now bearing its fruit, they have always welcomed the contribution, under suitable but non-discriminatory legislation, of all who wished to be, and were capable of being associated in this work, in the interest of France and the Community.

This broad-mindedness was recognized at a more or less early date by French and foreign private undertakings. In some cases, the response came even before the first important discoveries had been made; other investors needed the encouragement of technical results. On the whole, private cooperation is now considerable and greatly exceeds the contribution of the state.

This collaboration, approved and encouraged from the very beginning by a public authority which has maintained the rights of the state, safeguarded the future of the Community countries, without confining itself to a self-sufficient role no longer suited to our modern world, is now bearing its fruitful results.

Special emphasis in this connection must be laid on the importance of the results obtained in the Sahara and the prospects which they open up to European economy. During 1958 almost 500,000 tons were transported through the small Hassi Messaoud-Touggourt pipeline and by the Touggourt-Biskra-Philippeville railroad. But the problem of moving the oil will be mainly solved when the Hassi Messaoud-Bougie pipeline has been finally laid. This pipe, 660 km long and 60 cm in diameter, will enable 15 million tons to be transported per annum by 1961. Already 200 km have been laid in the South and 80 km in the North. Work will be completed during the summer of 1959 and 4,500,000 tons will be shipped through this pipeline in 1960.

Negotiations with Tunisia have led to an agreement providing for the passage over Tunisian territory of a pipeline for moving the production from the Eastern Sahara. Work on this pipe, extending from In Amenas to La Skira, will begin during the summer of 1959 and will be completed in a year. When finished, the installation will comprise four pumping stations, and 13 million tons of oil will be transported annually over 780 km through the 60 cm pipe.

(Continued on page 57)

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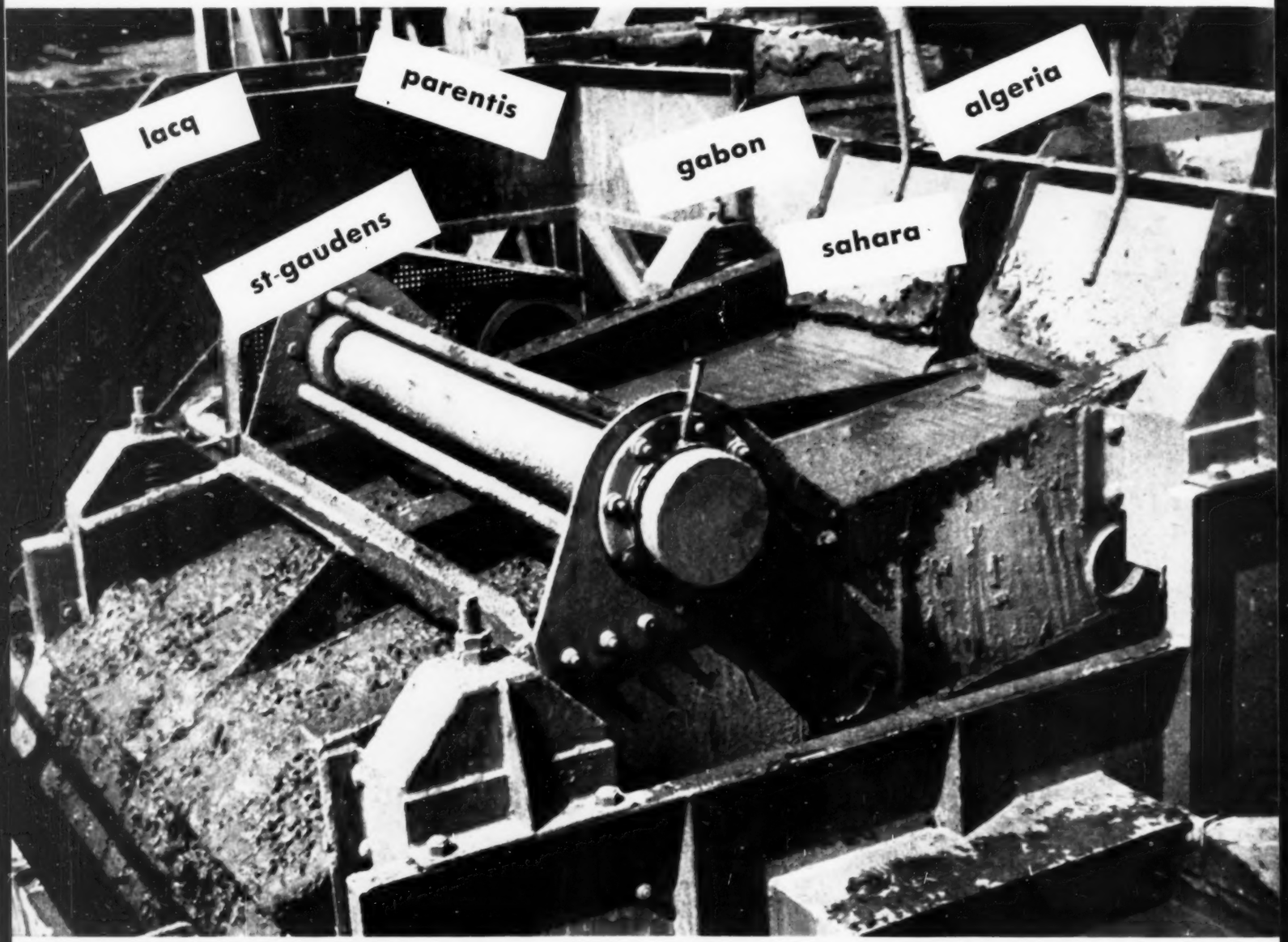

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by
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The Background. It is well known that the petroleum industry in France has a prominent place, as do other industries connected with this activity. We would like to give here some information which will lay stress on the extensive development of oil equipment manufacture in this country as required by the search for oil, by refining and distribution.

The oil industry is not new in France. As early as 1930 indeed, a set of modern refineries had been built, with a capacity that easily covered the needs of the country and its overseas territories. By the end of world war II, most of the installations had been destroyed. But a reconstruction program was rapidly undertaken as early as 1949, the French needs in finished products were again covered thanks to the new refineries which were built up on up to date basis in cooperation with engineering offices, most of them American. At present the capacity which had to be steadily increased in line with the expansion of the market, is over 35 million tons per annum. It is planned that this capacity will go on increasing and particularly thanks to the construction of two large refineries in the East of France, which will be fed from Marseilles by means of a pipeline, the construction of which has recently been approved by the government.

Needless to add that the supply of finished products to consumers of any category is assured by an adequate set of tankcars, trucks and coastal boats. As regards tankers, more than 82% of crude and finished products are transported under the national flag.

On the other hand, well known specialists have described in this book the magnitude of the discoveries and work that are now carried on in Algeria and in the Sahara.

The present situation. In view of this situation, we wish to emphasize the part played by French manufacturers in the realization of these important achievements.

As regards refining, it can be stated that this country is now of age for the construction of required equipment. Indeed, 95 to 98%, that is to say nearly all the equipment in operation in our present refineries has been constructed and erected by suppliers in this country. In fact the design of these units has been very often awarded to Americans, which led the French manufacturers to the important and difficult work of adaptation to American specifications. For steels, non-ferrous metals, refractories, control equipment, valving, etc., appropriate equivalents were worked out and developed in connection with the necessary quality of materials, dimensions, tolerances and test methods. The equipment that is still imported consists of items that are not frequently required, and the construction of which in this country would imply investments that would be out of proportion to the market.

On the contrary, one must notice the importance of French exports of refining equipment, that is of unitary items such as pressure vessels, fractionating towers, etc., as well as of complete units, among which we like to mention the Cubatao refinery in Brazil and the new Finnish refinery; both were erected by the French industry in close cooperation with engineering offices installed in France. The latter remark leads us to state that several new engineering offices are now developing their activities with quite a minor foreign participation.

As regards tubes for transfer and pipelines, pipestills, drilling, etc., France has now at her disposal a set of up to date workshops which allow her to meet the demand in all sectors, in spite of the fact that this demand has been increasing in an extensive as well as unexpected way due to the starting exploitation of the oil and gas sources of the Sahara. Moreover, the tonnage of exported tubes is an important amount of the total quantity manufactured.

As regards exploration and drilling, several major companies devoted their activities right after the war to the study and fabrication of all expendible equipment for which importation has therefore now become negligible. In addition to that, several companies among the above, have been awarded the A.P.I. monogram.

In the case of heavy drilling equipment medium and deep well rigs and masts had to be imported for a long time, but several companies now have acquired fabricating licenses, so that the percentage in value of this equipment either of French manufacture or fabricated under license, has passed from about 35% in 1957, up to 56.5% in 1958. This percentage will be in the vicinity of 90% in the course of the present year. The elements that are still imported now basically apply to instrumentation and flooring.

Finally, we like to mention the success obtained by French technologists in the study and development of turbo-drilling and also in the solutions obtained in connection with the problems created by the highly corrosive Lacq gas for the exploitation of which these solutions proved to be definitely satisfactory.

On the basis of the results thus obtained, it can be stated that the French petroleum equipment industry can meet the new requirements as well as the new conditions that may arise in France as well as in other countries in the exploration and exploitation of crude oil and natural gases, whatever their characteristics might be.

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General View of the Beziers plant

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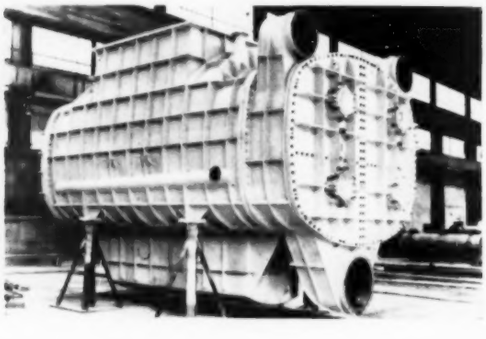

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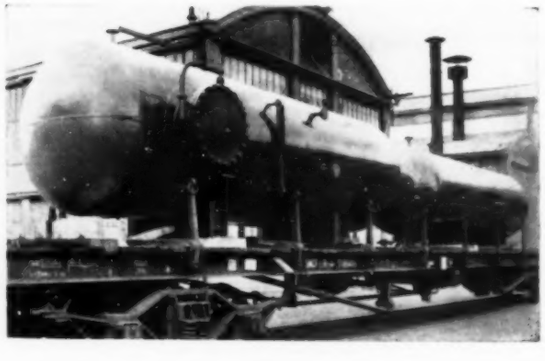
H. P. Tanks



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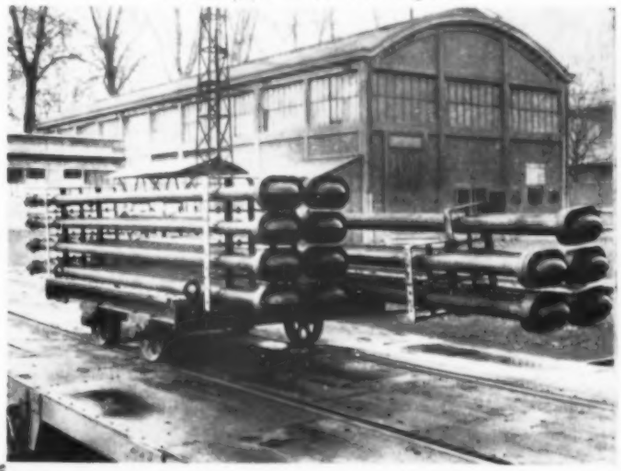
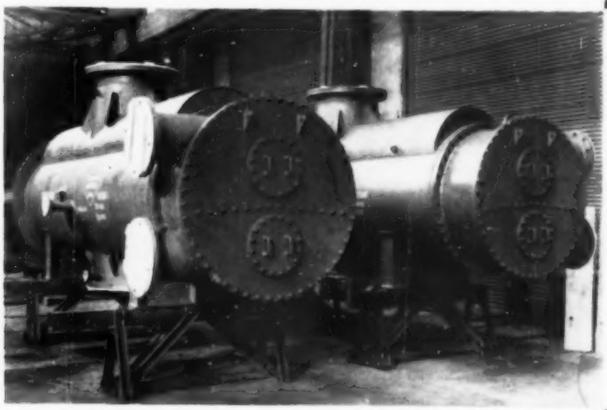


Surface condenser



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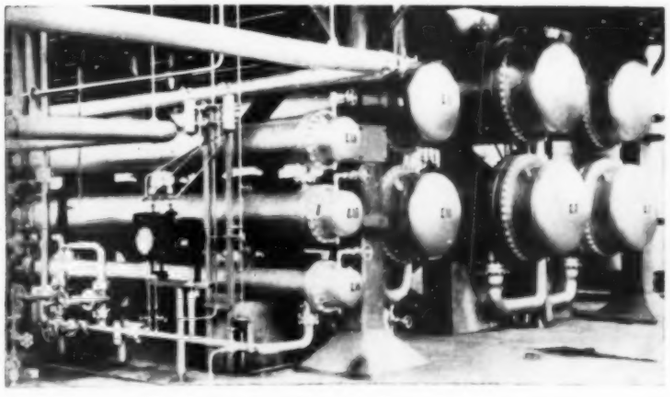

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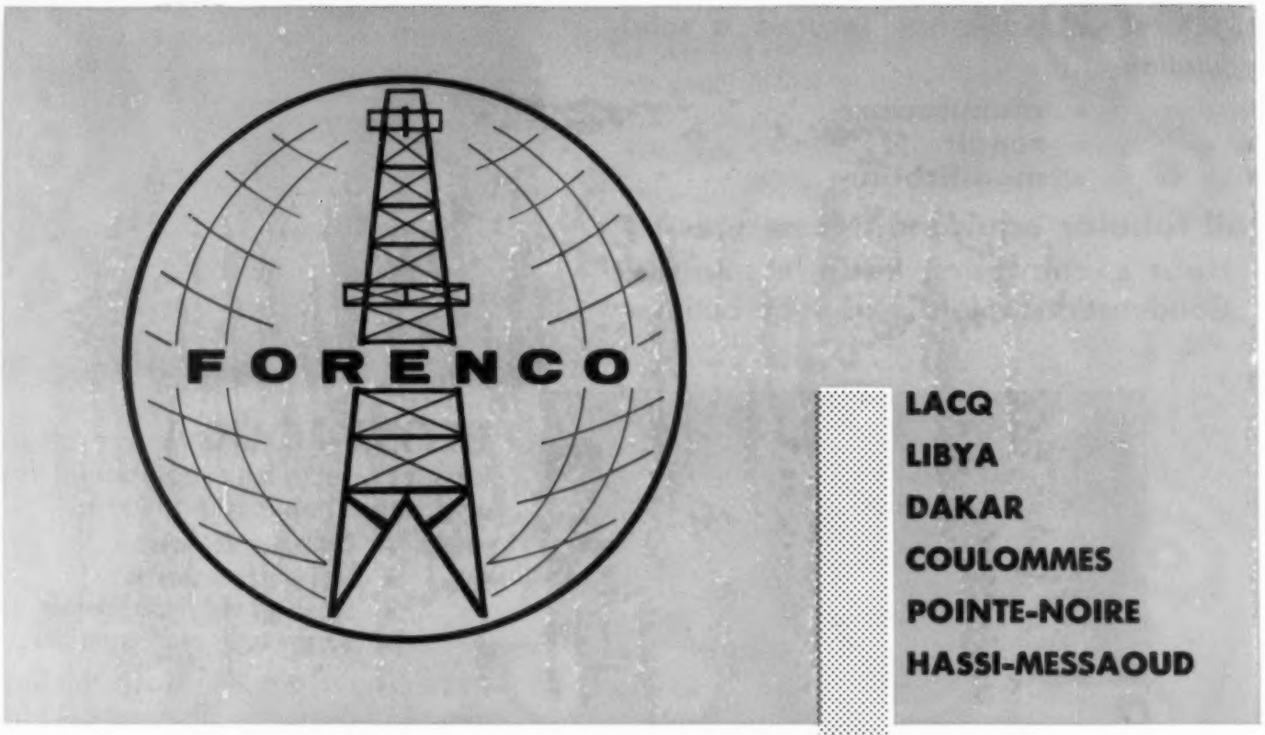

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One of the exploitation wells in the Hassi Messaoud field.

The Importance of Sahara Oil

by V. de Metz
President Managing Director of Cie Français des Pétroles
Director of Cie Français des Pétroles (Algérie)

In 1958, small quantities of petroleum from the Sahara oil fields found their way to the Mediterranean Coast, the transportation being operated as far as Touggourt by a small 6-inch pipeline. At Touggourt the oil was transferred to tank cars which carried for the remaining distance to Bone. Although it is impossible to make an accurate estimation of the reserves, it is already positive that they are large enough to justify the laying of a 24-inch pipeline to the sea. Only a few months from now, when this pipeline is completed, the Sahara will enter the phase of commercial exploitation as an oil producing area of international importance.

After a few years of exploration, several major discoveries of oil bearing sections occurred in 1956 at Edjele, Hassi-Messaoud and Hassi R'Mel.

The Edjele field, in eastern Sahara near the Libyan border, was the first of any significance. Since then, other fields have been found in the same district, at Zarzaitine, Tiguentourine, El Adeb Larache, etc. . . . Because of their distance from the coast, these fields will not be fully developed until the completion of the 24-inch pipeline whose terminal will be in the Gulf of GABES, in southern Tunisia and which is to be put into operation in the latter part of 1960. Equipped with one pumping station, this pipeline will at first have a capacity of 7 million metric tons a year, which could be substantially increased by the putting into operation of three additional pumping stations.

Further up north, at Hassi-Messaoud, about 430 miles southeast of Algiers, the exploitation of the field has already been started but the means of oil transportation to the Mediterranean coast are still provisional by small diameter pipeline and railway.

As pointed out here above, the work of development is under way (laying of a 24-inch pipeline to Bougie). The capacity of the 24-inch pipeline, at first approximately 4.9 million metric tons a year with one intermediate pumping station, will rapidly rise to 9 million metric tons a year in 1960 when a second station is in operation.

The crude oil found in the Edjele and Hassi-Messaoud districts is of a light variety and contains no sulfur.

At Hassi R'Mel, south of Algiers, it is not oil but natural gas that has been found in enormous quantities. The importance of this field greatly exceeds the present and future needs of Algeria. However, plans for the use of this gas on the European market are made difficult by transportation problems of a size never encountered before.

An important discovery was made a few weeks ago at El Gassi, about 60 miles south of Hassi-Messaoud. The same characteristics as those of Hassi-Messaoud—a 100 meter thickness of oil bearing strata—have been found. Other promising signs of oil have been evidenced only recently in other districts in the Sahara, such as Bordj-Nili, 42 miles north of Hassi R'Mel. It is still too early to evaluate with accuracy the scope of these new discoveries.

What is then the sum total of the results obtained in the Sahara up to the present day? If we take into consideration the reserves which have already been proved and the pipelines presently being built or planned, it can be anticipated that the oil production in the Sahara will in a few years reach 20 million metric tons a year.

This figure should be considered in connection with the French consumption of petroleum products, which will by then exceed 30 million tons a year. With respect to size, therefore, present Saharian certitudes are on a scale with French consumption. France thus will have accomplished an important step toward the solution of her energy storage.

Meanwhile, oil exploration in the Sahara is actively being carried on. Numerous companies which have been given exploration permits are now starting their operations—French companies sponsored by public or private capital, "independent" American companies, large international companies—either individually or in association.

One may be assured that such a substantial exploration effort, in a region where momentous results were already achieved in a short time, will lead to new success.

Under such conditions, there are grounds for considering that within the next decade Saharian petroleum production will come to play a part of European, and even world, importance. Of course, there is no thought of the resources of the Sahara being large enough to meet alone all of Europe's petroleum requirements. Present total consumption of European countries is approximately 150 million metric tons a year, supplied for the greater part by the Middle East. But the Sahara will be added to the still small list of producing-exporting areas which together meet the world's oil needs: Venezuela, the Middle East, and to some extent the Far East.

Saharian production, even though it could cover only a relatively small portion of world oil requirements, will provide some flexibility and a complementary margin of security to supplies for the Western World. From that point of view, this new source of oil constitutes an important event.

It is from this standpoint that it is reasonable to consider that Saharian crude oil —a very light crude—should in a short term take its place and fulfill its part in the broad streams of international petroleum trade.

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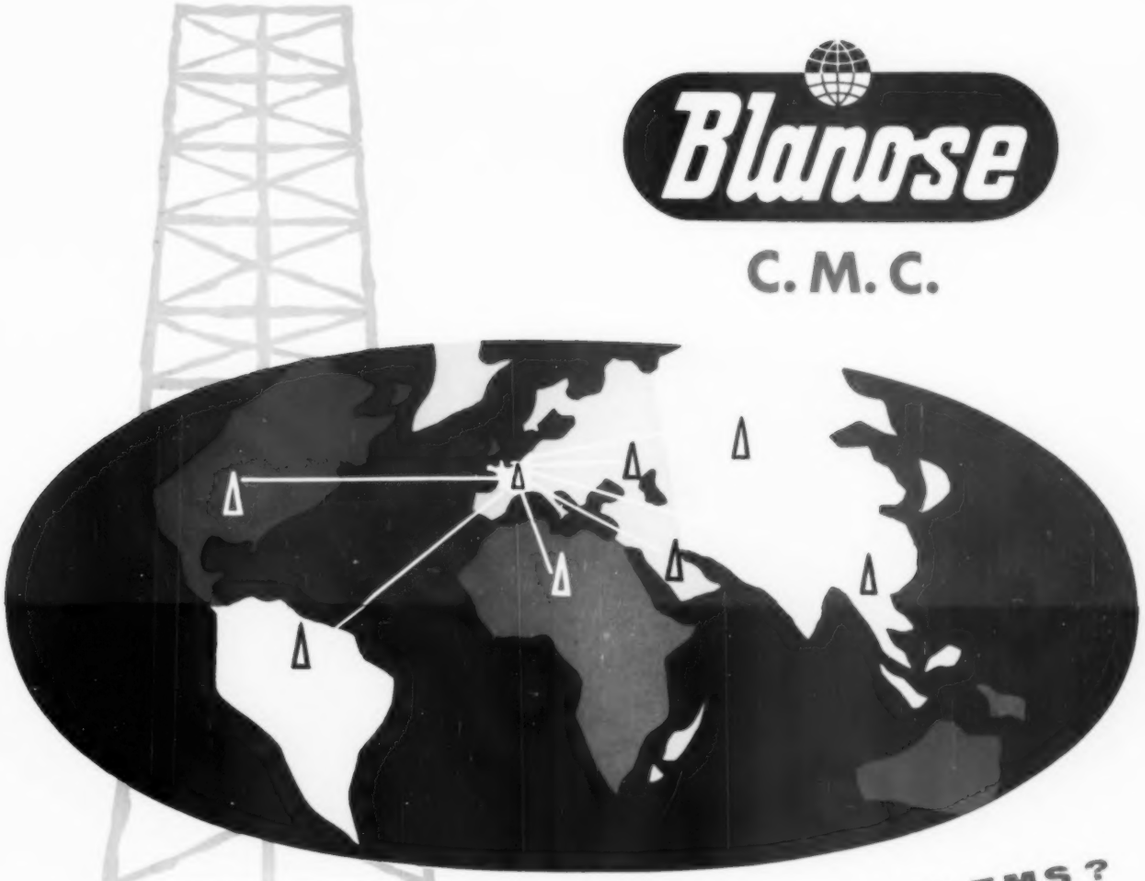

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CREPS—A Sahara pioneer

by Paul Moch
President Managing Director of Cie de Recherches et d'Exploitation de Pétrole au Sahara (CREPS)

Prior to 1951, no systematic petroleum exploration had been undertaken north of the Hoggar. No petroleum exploration permit had been applied for, and the whole country was virtually unexplored.

In 1952, C.R.E.P.S. asked for permits in that area and, without waiting for them to be granted, started air photography, photogeological interpretation and surface geological studies. In May 1953 56,100 square miles of permits were assigned to the company. They were divided into two parts, one of them around In Salah, in deep south-central Sahara, the other north of Fort Polignac, close to the Libyan border

Gravity and magnetic geophysical studies were begun on the Western perimeter in 1953. These studies now are complete and have been succeeded by telluric measurements or core drilling. The seismic reflection method has been used only since 1954 to improve the accuracy of previous results, or, more rarely, as an exploration method.

One year after the beginning of the first work, in December 1953, the first well was located near In Salah, at Bergal on a geological structure, and in February gas was encountered which flowed at the rate of 800,000 cubic feet/hour. It was the first well to prove hydrocarbons in the Sahara.

Exploration wells drilled later on C.R.E.P.S.' Western acreage (there are 26 of them at the end of 1954) tapped numerous important gas structures and sometimes small quantities of liquid hydrocarbons: Bahar el Hammar, Djaret, Mouahdrine, Mahbes Guenatir, Tibaradine, Tirechoumine, Zini, Thara, En Bazzene, In Salah, Meredoua, Gara Azzel Matti.

C.R.E.P.S.' eastern acreage is more characteristic. Due to extremely difficult conditions, exploration began there later than on the Western permits, and three years after the first Saharian and C.R.E.P.S. oil fields were discovered they are just now reaching the exploitation stage.

As a matter of fact, the first commercial oil in the Sahara was tapped at Edjelah 101 six miles from the Libyan border which was the first well drilled on the Eastern Acreage. Spudded in December 1955, the discovery well was tested on January 6, 1956 at an initial rate of 500 to 600 bbl/day of 35° API crude. Step out drilling was at once undertaken and this has shown that Edjeleh has four different irregular reservoirs and a main fault on the east flank.

Not long after this first success, in June 1956, another crude pay was obtained at Tiguentourine, a barely visible surface structure, 45 miles west of Edjeleh.

The biggest discovery was made some time later, in January 1958, at Zarzaitine, by the second deep well drilled on a structure about 35 miles north of Edjeleh and near the Libyan border. Zr 2, located south of the gas deposit discovered by the first well, found 164 feet of oil saturated lower Devonian sand from 4,360 to 4,525 feet and was completed flowing 3,200 b/d of 43° API oil. As of mid-1958, two Carboniferous gas zones, one Ordovician gas pay and the lower Devonian oil zone had been proven at Zarzaitine, with favorable porosity and permeability.

Beside these commercial discoveries, nearly every exploration well, on the Eastern permits, proved successful. The most important are Oued Oubarakat (16 b/hr) in April 1958, El Abed Larache (113 b/hr pay in Devonian) in May, and Ouan Taredert and Dome-a-Collenias where Ordovician zone yielded 32 to 38 b/hr. At the beginning of January 1959 a good oil test was obtained at Hassi Mazoula.

The Zarzaitine find is only one year old, but has already proved to be the second largest strike so far in the Sahara, and number one from the economic point of view. Porous sandstones are 131 to 197 feet thick in the main prolific reservoir. The average depth is only 4,590 feet so that a well capable of producing 1,500 b/d can be completed in three weeks, rig moving time included. The field is estimated to contain not less than 600 million bbl of proven recoverable reserves, and is far from having been outlined.

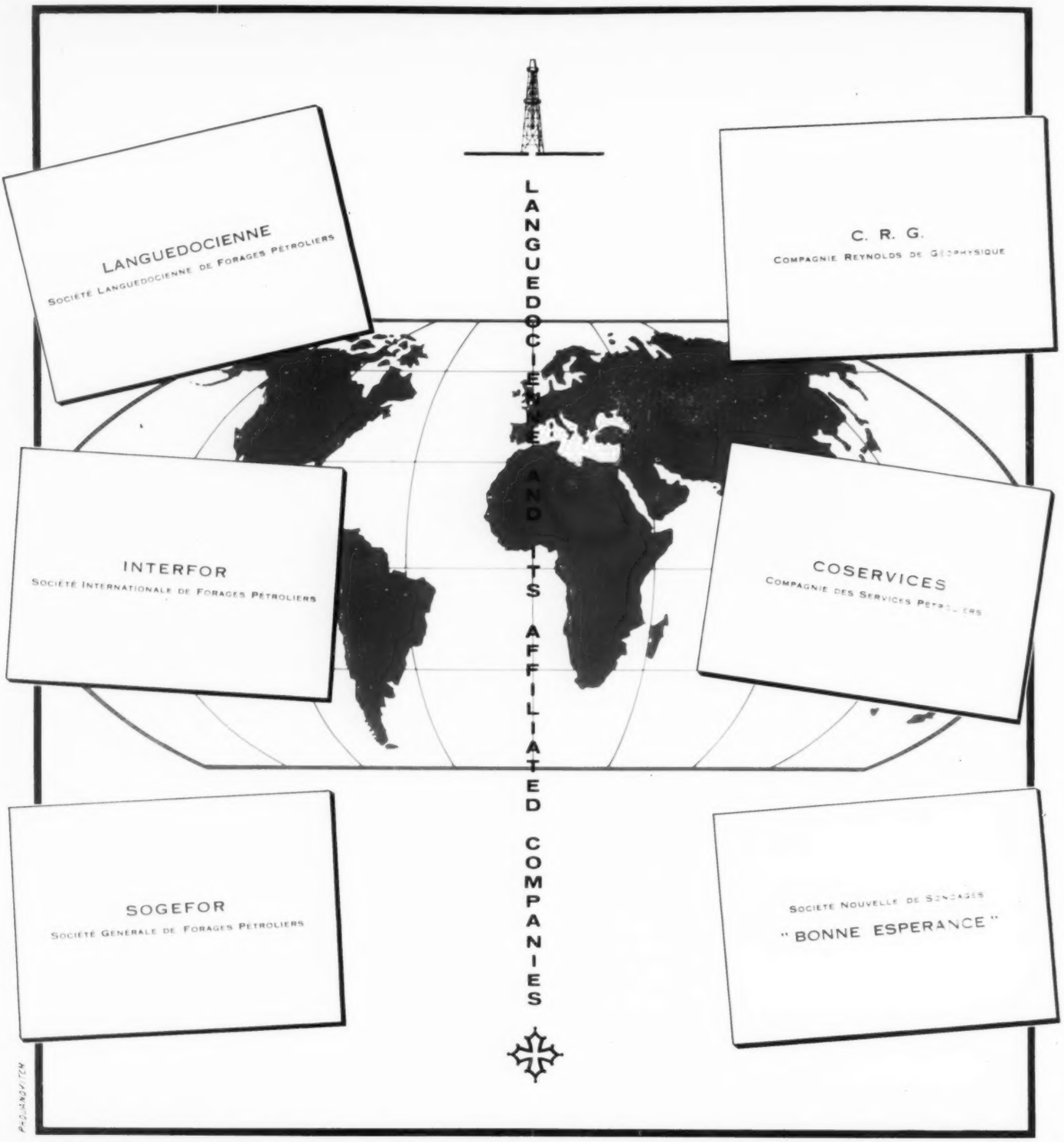
Plans for gathering system have been completed and submitted to contractors. Bids on the supply of needed equipment will be shortly received.

Both strikes will be brought into production very soon. C.R.E.P.S. puts at a most conservative 70 million bbls the reserves of Tiguentourine, half as much for El Adeb Larache, and 220 million bbls in the case of Edjeleh. Together with the potential of Zarzaitine, total reserves of all four finds would aggregate 900 million bbls. These estimates do not take into account the important additional reserves of more recently discovered fields, which may hold big surprises in store for the future. Production is expected to reach 150,000 b/d in 1961.

To bring crude to the Mediterranean, C.R.E.P.S. created in 1957 an affiliated firm, TRAPSA. TRAPSA is in charge of constructing and operating a 24" crude line running 485 miles from In Amenas, at a central point in the oil fields to La Skhirra on the Tunisian Mediterranean coast, where a marine survey of the local bay is being conducted.

Orders for 90,000 metric tons of welded pipe that the line will use have been placed. The first shipment was expected to be on hand in May 1959, and the actual welding work itself should start four months later. Construction work on the In Amenas storage facilities has already started. A 1,200,000 bbl tank farm will be provided at the sea terminal. As In Amenas sits at 1,092 feet above sea level, it will require a booster station to pump the crude up the 650-foot Tinrhert cliff, which is the highest point on the whole route; whence, oil will flow by gravity to the Mediterranean at an initial rate of 100,000 b/d. Three additional statioons will raise the flow to 280,000 b/d.

The first tanker is expected at La Skhirra on October 1st, 1960. By 1961, eight years after its geologists first started working in the Sahara, C.R.E.P.S. expects to provide France with 25% of its total consumption of oil products.



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"LANGUEDOCIENNE" GROUP

Introducing the "Languedocienne" Group

At all stages of petroleum exploration, "Languedocienne" and its subsidiaries offer to exploration companies their specialized services:

—in the field of geophysics: "Compagnie Reynolds de Geophysique (C.R.G.)" offers the most up to date techniques with respect to seismic, gravimetric, re-interpretation, playback and geological techniques.

—in the field of drilling: "Languedocienne" and its subsidiaries have at their disposal experienced technicians, skilled drilling crews and the latest equipment well adapted to modern drilling techniques. They are particularly specialized in turbodrilling.

—in the field of specialized work:

"*Bonne Espérance*", well known for its mining work, has, since 1957, extended its activity to the preparatory work for petroleum exploration, especially drilling for industrial and drinkable water research, which, in the Sahara, necessarily precedes exploring for oil.

"*Coservices*" offers to exploration companies in France, in French North Africa and in Overseas Territories, its services for testing, cementing, finishing jobs, directional drilling, mud consulting, etc. . . .

History

"Société Languedocienne de Forages Pétroliers (Languedocienne)" was founded in 1955 and grew out of the "Société Nationale des Pétroles du Languedoc Méditerranéen" (which became "Compagnie d'Exploration Pétrolière"), taking over the drilling activity of this company.

Its growth is represented:

1. by an increase in the number of its rigs, from 7 in 1955 to 19 in 1959.
2. by the creation or development of other drilling companies:

—in 1955—creation, in equal shares, with the Italian Company "Azionaria Imprese Perforazioni," of the "Société Internationale de Forages Pétroliers (INTERFOR)";

—in 1957—creation, in association with the "Société Générale d'Enterprise," of the "Société Générale de Forages Pétroliers (SOGEFOR)";

—acquiring participation in the Société Nouvelle de Sondages Bonne Espérance".

3. by a broadening of its field of action, in the form of participation in:

—"Compagnie de Services Pétroliers (COSERVICES)," in which it holds 40% of the present capital.

—"Compagnie Reynolds de Geophysique (C.R.G.)," whose principal shareholder is the American company, Reynolds Geophysical Company, which contributed to the new company its techniques, patents and specialized equipment which is manufactured in the United States.

Resources

1. Drilling rigs available as of December 31, 1958

In the field of drilling, the "Languedocienne" Group has a wide range of rigs available, as is shown in Fig. 1.

2. "Coservices" equipment as of December 31, 1958

—10 cementing and pumping units,
—41 strings of "testers,"
—miscellaneous equipment for fishing jobs,
—miscellaneous equipment for directional drilling.

Activity

1. "Compagnie Reynolds de Geophysique"

Immediately after its incorporation, C.R.G. started its activity by operating:

—Crews for seismic reflection and gravimetric work,
—a magnetic recording of playback service,
—a seismic reinterpretation service,
—a rental service for Reynolds cameras.

2. The "Languedocienne"-"Interfor"-"Sogefor" drilling group

Footage drilled in 1958 by:

—"Languedocienne": 312,000 feet, (176,000 feet of which in Metropolitan France and 136,000 feet overseas)
—"Interfor": 174,000 feet
—"Sogefor": 43,000 feet

529,000 feet

—"Languedocienne's" customers:
C.E.P.
C.F.P.A.
COPEFA
ESSO-REP
PETROREP
SAFREP
S.N. REPAL
S.P.M.
TRANSWORLD, etc.

—"Interfor's" customers:
AGIP MINERARIA
C.E.P.
GAZ de FRANCE
S.N.P.A.
S.P.V.

—"Sogefor's" customers:
COMPAGNIE FRANCAISE des PETROLES (GASCOGNE)
ESSO-REP

3. "Société Nouvelle de Sondages BONNE ESPERANCE"

This company was specialized in mine drilling and the construction of specialized mining equipment; in 1956, it began petroleum drilling on a small scale.

Its number of rigs includes 14 light rigs, one of which, built by Haniel and Lueg, is now drilling for "PREPA".

4. "Compagnie des Services Petroliers"

The activity of the company during 1958 is shown by the following figures:

665 cementing jobs
695 drill stem testing jobs,
36 directional drilling jobs,
116 fishing jobs,
119 acidizing and fracturing jobs,
115 pumping jobs,
22 mud service jobs.

These activities are carried out from ten operating locations (5 in Metropolitan France and 5 in the Sahara).

Future Prospects

The six companies constituting the "Languedocienne" Group, well established both in Metropolitan France and Overseas, now expect to extend their activity to other continents.

Fig. 1.

	Languedocienne	Interfor	Sogefor	Bonne Espérance	Total "Languedocienne" Group
Heavy rigs	3 Ideal 100 1 Ideal 80 B 4 Emsco 800	3 Ideco 5.7.11 1 Ideco 1350 S	2 Ideco 5.7.11		14
Medium rigs	3 Ideal 50 1 Ideco H 525 2 Emsco 250	1 Ideal 75			7
Light rigs	2 Cardwell 8	1 Mavio vert		1 Haniel & Lueg	4
Servicing Unit	1 Cardwell 8				1
Total	14	5	2	13	26
Water and Mining drills				13	13

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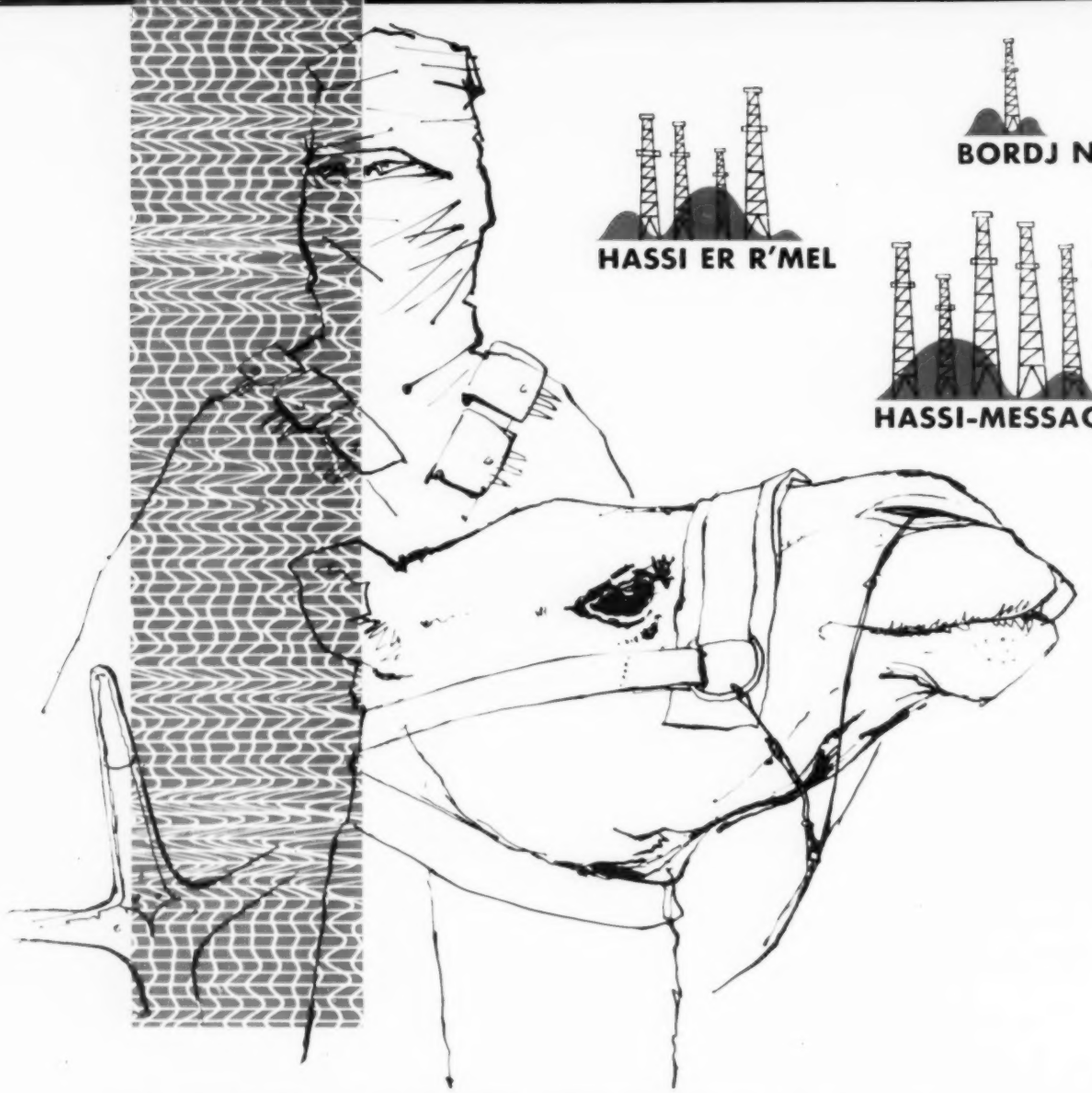

SN REPAL

SOCIÉTÉ NATIONALE DE RECHERCHE ET D'EXPLOITATION DES PÉTROLES EN ALGÉRIE

BERNEX FOTIEN

GENERAL OFFICES : BIRMANDREIS (ALGIERS) - PARIS OFFICES : 23 RUE GALILEE XVI^ème

History of SN REPAL geological exploration

by Roger Goetze
President Managing Director of S.N. Repal

PROSPECTING for oil in a new area usually proceeds according to a fairly conventional plan split up into two phases. The first phase consists of a geological study leading to the boring of the first wells. The second stage consists of geophysical exploration to define surface structures or determine other traps.

1 First stage—Determination of petroleum problems.

(a) From the point of view of nature of the subsoil, as the only landmarks consisted in outcrops situated several hundred kilometers from one another and outside the zone covered by the permits, it would have been impractical to make rock sections on the permit zones themselves, and the prospectors had to proceed directly to stratigraphic drilling based on hypotheisis.

The first large stratigraphic boring in the Sahara was made in 1952 in the Berriane permit area, known as "Berriane No. 1 (Be 1)". After cutting through the Intercalated Continental, it successively traversed a lagoonal-marine Jurassic and the Trias, comprising first a thick salt series, then a clayey series and, finally, a large sandstone formation resting on the Cambrian-Ordovician system. This first boring which can correctly be considered to have been of fundamental importance for our subsequent discoveries, especially those of Hassi er R'mel, brought up the first Saharian oil problem. Under a salt series playing the part of an impermeable roof, it showed the presence of an excellent shut-in reservoir constituted by sandstone containing salt water under high pressure, with signs of gas, oil and asphalt.

The second stratigraphic well was bored in the zone covered by the Oued Rharbi permit. This "Oued Rharbi No. 1 (OR 1)" boring, after cutting through the Intercalated Continental, then the reduced Lias and Trias series, entered a complete Paleozoic series where signs of oil were found in the Lower Devonian sandrocks.

A second problem linked up with this Lower Devonian reservoir was thus encountered.

The CFP "A", on its part, was making the El-Golea boring which also revealed a Devonian and a Silurian formation, both complete, under a Mesozoic of comparatively little thickness.

(b) From the point of view of structure of the subsoil, prospecting was necessarily entirely geophysical.

In 1951, the results of the seismic reflection method were not satisfactory. On the contrary, the seismic refraction method, which enabled the structure of large areas to be quickly ascertained, soon became of foremost importance profiles covering more than 6,500 kilometers were prepared by the C.F.P. "A"—S.N. REPAL Association within four years, 1952 to 1956.

2 Second stage—Exploration.

(a) Starting from the ideas suggested by the results of the Be 1 boring, the Hassi el Hadjar No. 1 (HD 1) bore-well, about 70 km south of Ouargla, was drilled in a structure selected by seismic refraction. This boring showed the presence of a Triassic series with no reservoirs. However, the results encouraged the prospectors to continue their exploration much further.

(b) At the same time, the problem of the Lower Devonian reservoir, brought up by the OR 1 boring, was studied by means of the OR 2, OR 3 and OR 4 borings, but, on account of the variations in quality of this reservoir, no accumulation of oil in commercial quantities could be ascertained.

(a) *Hassi Messaoud No. 1.* Beyond and eastwards of the HD 1 boring, seismic exploration by refraction methods showed the existence of a high zone, about 100 km E.S.E. of Ouargla, and this site was chosen for drilling the Hassi Messaoud No. 1 (MD 1 well. The exact spot was determined in June 1955 and drilling was begun on January 10, 1956.

After passing through the argilloraenacecus layers of the Mio-Phocene, down to 255 m, it reached the Senonian, represented over a thickness of 560 m by alternate beds of limestone, anhydrite and salt. Then came in succession, from 817 to 2,000 m, the calcareous Turonian, the Cenomanian with a lagoonal-littoral facies, and the thick argilloarenaceous complex of the Intercalated Continental, from the upper strata of which fresh artesian water flowed (Albian sheet). From 2,000 to 3,210 m, it passed through the alternating beds of Lias clay, dolomite and anhydrite, the thick massive salt series and the red azoic clays, with sandstone passage Trias beds.

On June 15, 1956, at a depth of 3,330 m, under the Triassic discordance, it finally penetrated into the impregnated sandstones of the Cambrian-Ordivician reservoir, found to be more than 140 m thick.

A test made in this formation, beginning in July, produced an abundant flow of anhydrous oil, the first positive sign of a discovery the importance of which was to be shown by its later development.

The disappointment caused by the absence of a reservoir in the Triassic sandrock was abundantly offset by the impregnated reservoir sandrocks of the Cambrian-Ordovician, shown by the Md 1 boring, but a third problem was raised.

(b) *Hassi Er R'mel No. 1.* The seismic refraction exploration carried out in the Mzab area after the Berriane boring had been completed showed the existence of a high zone, slightly to the south of the Tilrhempt Bordj. It was then defined by the seismic reflection method and the Hassi er R'mel No. 1 (HR 1) well was bored on it. Drilling was begun on September 10, 1956.

The boring first cut through the Senonian limestone, the Turonian dolomites and the argillocalcareous series of the Cenomanian, down to a depth of 185 m. It then penetrated the argilloarenaceous complex of the Intercalated Continental and at 755 m reached the argillocalcareous series of the Jurassic. Then came in succession, from 1,460 m downwards, an argillodolomitic Lias with anhydrite passage beds, then the massive salt series and the red clays of the Trias. At 2,132 m it entered the Triassic reservoir constituted over a thickness of 87 m by three sandstone horizons separated by clayey intercalations. Tests revealed the presence of damp gas as first evidence of the discovery of the extensive Hassi er R'mel gasfield.

3 Third stage—Discovery.

The main characteristics brought out by the development of these discoveries and further exploration work are:

The Northern Sahara as a whole is shown to be a vast succession of sedimentary basins. The characteristic and principal feature of its geologic history is that these basins were never subjected to the very intensive action of orogenic forces, and this fact has determined the undisturbed structure of its subsoil. The existence of very extensive oil and gas fields is due to this undisturbed structure. Nevertheless, the stratigraphic series show several discordances and several sedimentation discontinuities, which makes the existence of stratigraphic traps probable, the first of which was brought to light in the night of December 31, 1958 to Jan. 1, 1959, by the Bordj Nili No. 2 (NL 2) drilling in the sandstone series of the Muscovite.

And this brings up another petroleum problem which it is reasonable to assume will not be the last.

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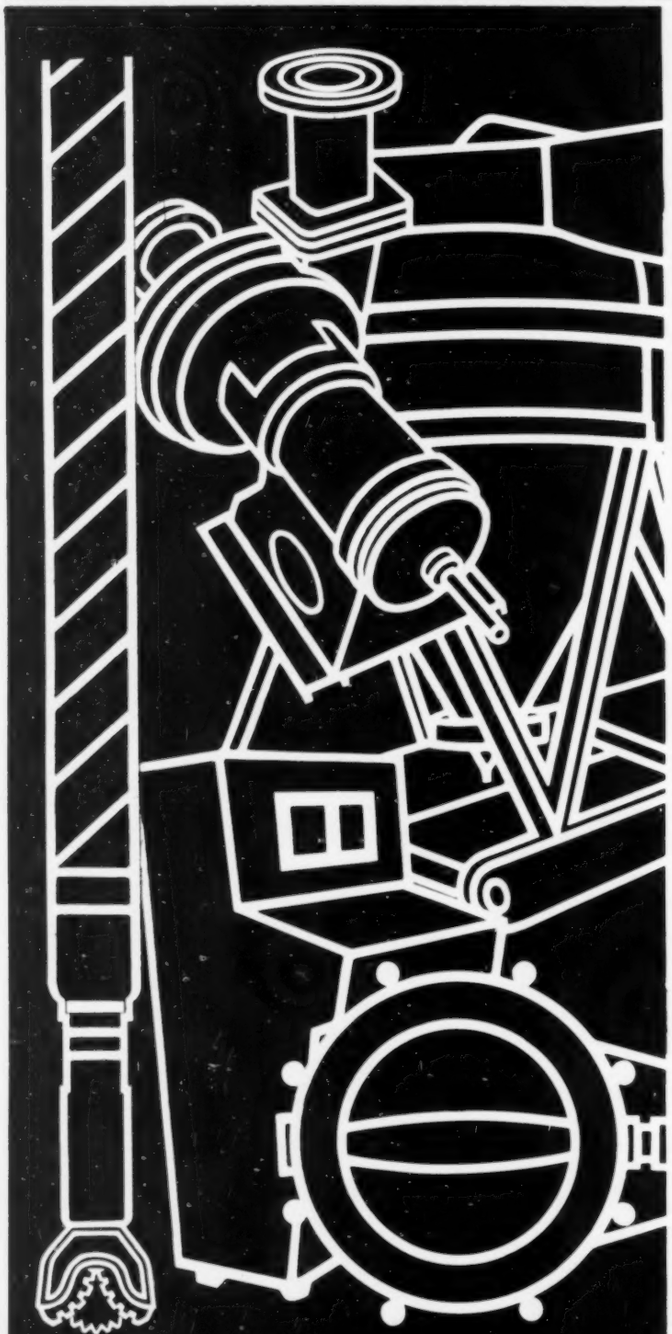

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Lacq Gas as a Factor of French economic prosperity

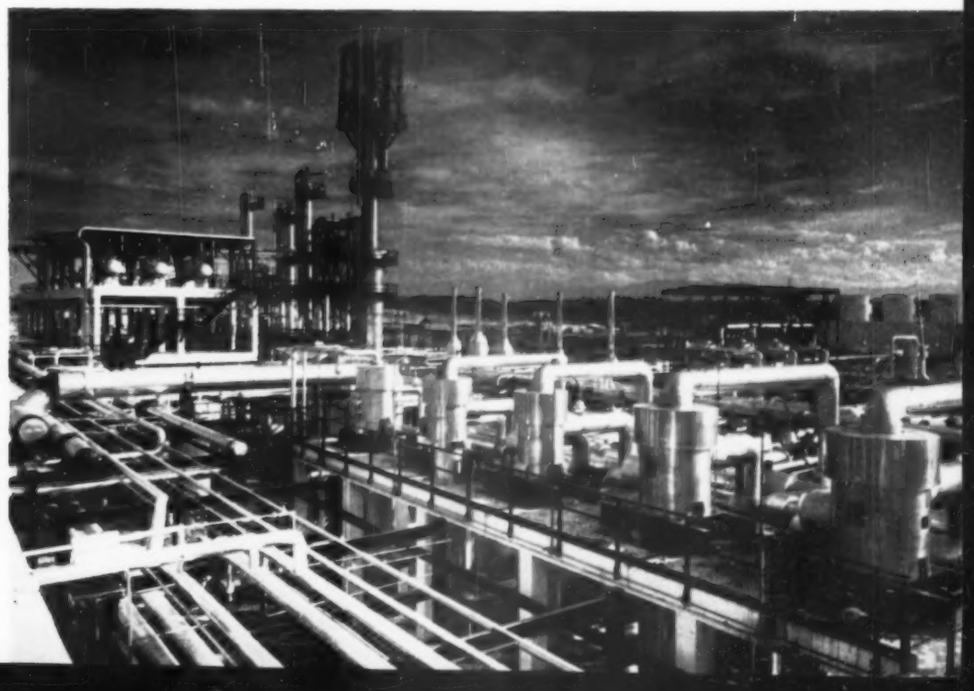
by André Blanchard
President Managing Director of Sté Nationale des Pétroles d'Aquitaine (SNPA)

Two natural gas deposits have so far been discovered in continental France, both in the Southwest, not far from the Pyrenees. The Saint Marcet deposit, near Toulouse, was discovered in 1939 by the "Régie Autonome des Pétroles," and its reserves, though limited, have been, and are still supplying natural gas to a number of cities and towns in the district, in particular Toulouse, Pau and Bordeaux. Lacq, the second gas field, was discovered at the end of 1951 not far from Pau by the "Société Nationale des Pétroles d'Aquitaine" (SNPA). Its large reserves, estimated at 280 billion m^3 of gas, some 200 billion of which are recoverable, will enable 20 million m^3 of crude gas to be extracted per day by the end of 1960. In spite of the renewed prosperity it will bring to economically under-developed southwestern France, only a small proportion of Lacq gas can be distributed in this area, and the greater part of production will therefore have to be transported over long distances to other areas of consumption.

The development of the Lacq deposit raised a number of difficult problems for the SNPA, but the company nevertheless persevered in its efforts. Whenever possible it used or adapted methods which had been applied in other countries in dealing with difficulties of a similar nature. But existing techniques were not adequate to meet some of the problems which had never been encountered elsewhere. The SNPA engineers were fortunately able to work out new methods, but it is no more than fair to say that they were helped in this task by their colleagues in other French industries, particularly the iron and steel industry, who also spared no effort in contributing to the success of an undertaking of such great national importance.

Lacq crude gas contains 15% H_2S and 10% CO_2. These acids cause considerable fissuring corrosion in the tubing currently used in prospecting for and developing hydrocarbons. This phenomenon was the cause of the blowout which occured at Lacq when the gas field was discovered, and which was controlled only after two months of effort, thanks to the invaluable cooperation of the American specialist Myron Kinley. This difficulty was enhanced by the particularly severe physical conditions characterizing the Lacq deposit (pressure of 670 kg cm^2 and temperature of 140° C), and its depth, 3260 m below the surface in the case of the La. 105 well, at the crest of the structure, and 4560 m in the case of the La. 116 well, the deepest so far in production at Lacq. Therefore, the various difficulties which occur separately in certain natural gas fields, due sometimes to pressure and temperature, and sometimes to the corrosive action of the gas, are all encountered together at Lacq.

It was found impossible to use standard tubing for extracting the gas, even when it was coated internally with plastic, for this equipment did not withstand the twofold effects of the temperature and corrosiveness of Lacq gas. But as soon as the deposit was discovered, the French metallurgical industry was asked by SNPA to work out and develop special steels capable of withstanding the fissuring corrosion of H_2S. The results of this research were entirely successful, and special steels with the required mechanical properties and proof against fissuring corrosion were developed by several French steelworks in cooperation with SNPA engineers. At pre-



sent several types of tubing made of these steels are being used at Lacq and are standing up satisfactorily to the fissuring corrosion phenomenon.

To make the Lacq gas marketable, SNPA has installed processing plants where the following operations are carried out: separation of the H_2S and CO_2 present in the crude gas; extraction of the sulfur contained in the H_2S, gasoline extraction, i.e. separation of the propane, butane and gasoline from the purified gas. The first section of this plant was started up in May 1957 and after new units have been successively put into service its capacity will reach 20 million m^3/d by the end of 1960. By reason of its size in particular, this type of plant is entirely new in Europe. It is based on techniques which have stood the test of time in the U.S.A.; but, beginning with the 2nd block of installations, SNPA has made certain improvements in these conventional methods. The equipment itself is almost entirely of French manufacture.

For transporting the Lacq gas to the areas to be supplied, the establishment of a system of large diameter pipelines has been undertaken; their total length will be 1500 km, exclusive of the branch lines to be connected to the network. The main feeders of the network consist of pipe made of steel with a high yield point, welded longitudinally and expanded.

The exploitation of the Lacq gas field will make a substantial contribution to the development of French economic wealth. When the rate of production of 20 million m^3 per day of crude gas is reached in 1961, the various operations carried on in the Lacq processing plant will lead to the annual supply of:

- 4 billion m^3 of purified gas (methane)
- 130,000 metric tons of propane and butane
- 250,000 metric tons of gasoline
- 1,400,000 metric tons of sulfur.

The purified Lacq gas is almost pure methane. Allowing for the calorific value of natural gas, the Lacq production of methane from 1961 on will amount to 2.5 times the present French consumption of manufactured gas. It is therefore no exaggeration to say that the Lacq gas will completely transform the French gas industry by substantially increasing its available supplies and changing its structure.

On the other hand, it is a known fact that French economy depends on other countries for more than a third of its energy requirements, but the deficit in this connection will be reduced by some 10% by Lacq gas and its by-products—propane, butane and gasoline.

Development of the French chemical industry will also be considerably influenced in the coming years by the exploitation of the Lacq gas field. Mineral chemistry will no longer have to import the sulfur it consumes. The supply of methane from Lacq will enable French production of ammonia, acetylene, methanol and other organic chemicals to be increased. The important

NATURAL GAS PIPELINE NETWORK
FEBRUARY 15, 1959

PRINCIPAL PIPELINES

PUT IN SERVICE IN 1958

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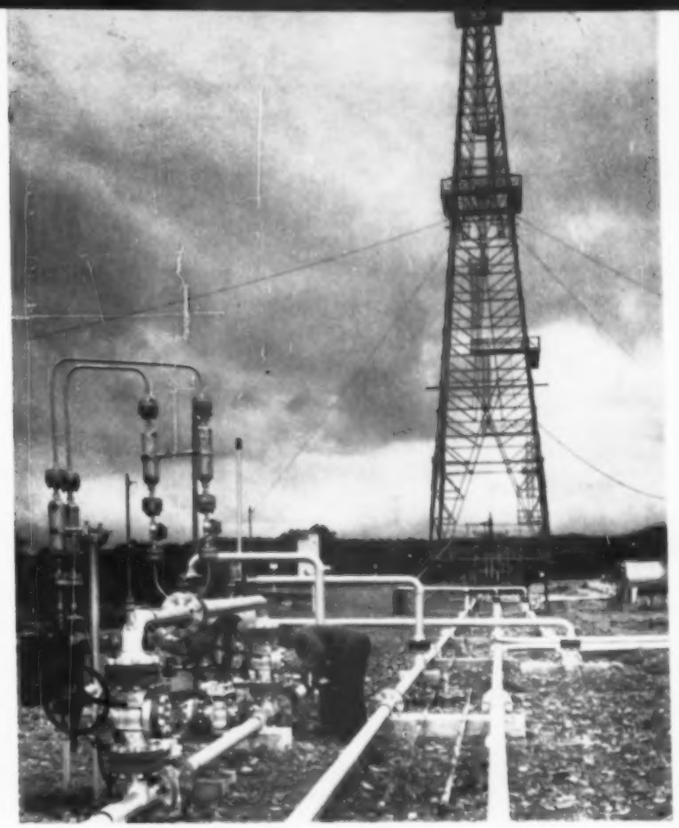
SECONDARY PIPELINE NETWORK

UNDER CONSTRUCTION OR STUDY



place taken by methane in this connection in countries like the U.S.A. where natural gas is abundant is generally well known.

Furthermore, the other hydrocarbons contained in the crude Lacq gas may well become the starting points of organic syntheses. In particular, part of the 3% content of ethane will be cracked, yielding ethylene for the production of polyethylene plastics.

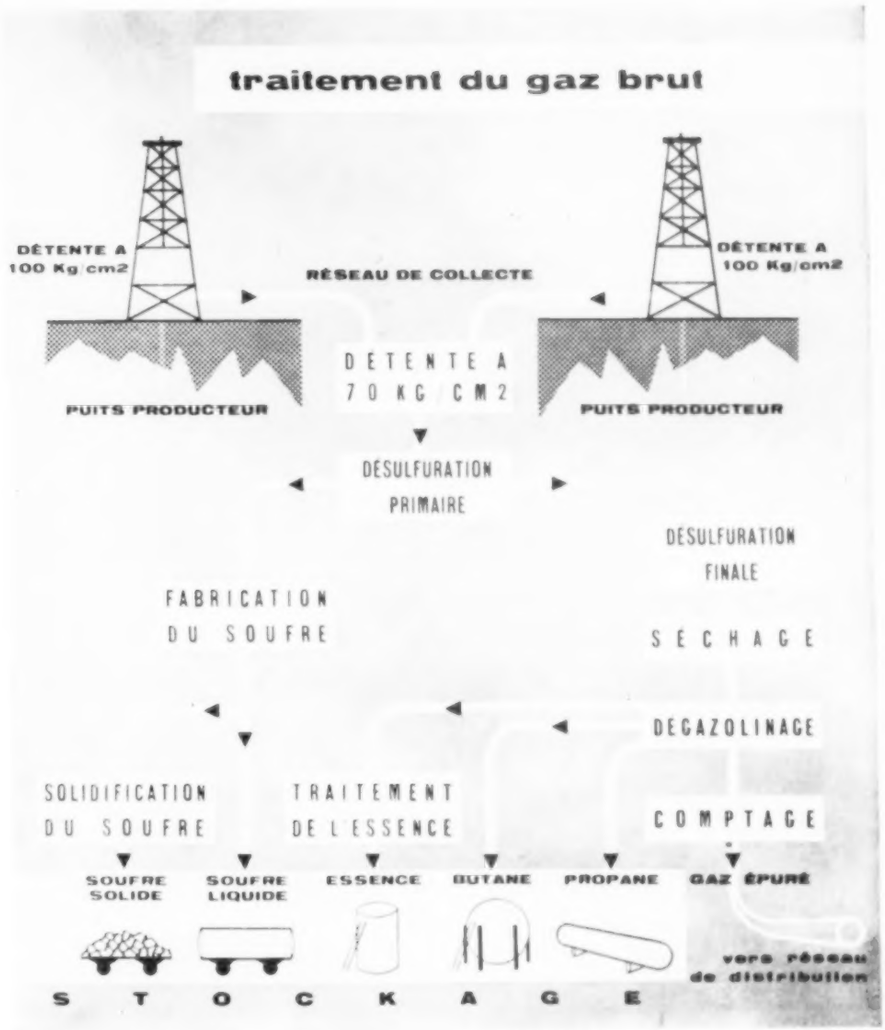
Not only will all the products extracted from Lacq crude gas be substituted on the French market for products which are now imported or manufactured from imported raw materials, but in addition, part of the sulfur production can be exported.

Lacq will therefore contribute substantially to reducing the present deficit of France's trade balance, which is one of the chief aims of the authorities responsible for the nation's economy.

We have already said that the greater part of the Lacq production of natural gas will be transported to areas other than the Southwest. The principal feeders of the pipe network will end in the Nantes, Lyons and Paris Districts.

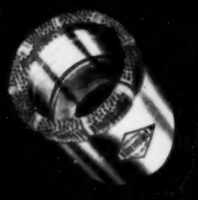
Nantes is the center of a district which, owing to its maritime position, may be considerably developed during the next few years, and this expansion will be facilitated by Lacq gas. Lacq gas will promote the economic prosperity of the highly industrialized Lyons area which comprises a large number of industrial consumers who, on account of the products they manufacture (fine metallurgy, chemicals, ceramics, glassware, ...), can derive the greatest advantages from the specific properties of natural gas.

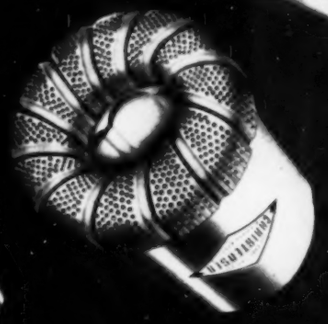
The Paris district will be supplied with all the gas which it will not be possible or advisable to market elsewhere. Its quantity will be limited and will be for the most



For each age
there's a tool

Diamond drilling is in stride
with the missile age





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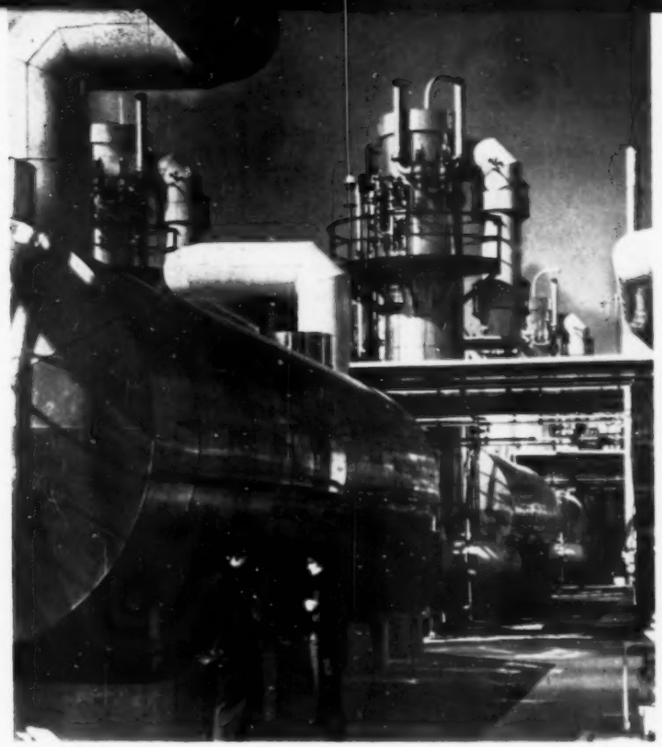
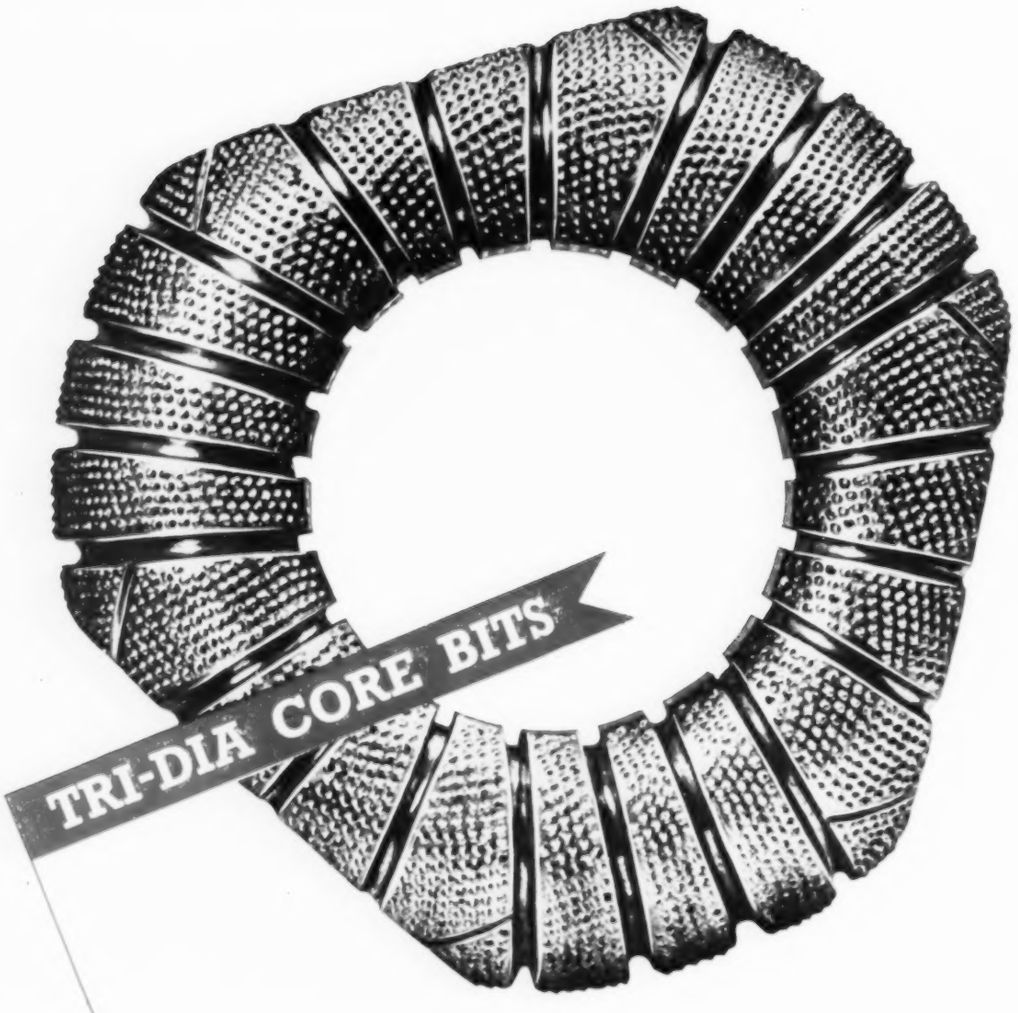


part absorbed by electrical power stations and public distribution. Industrial consumption will therefore not be predominant in this area. Consequently, the fact of bringing additional gas to the Paris district will not be prejudicial to the public authorities' efforts to decentralize French industry, some branches of which have tended to become excessively concentrated around Paris since the beginning of the century.

But the effects of working the Lacq deposit will be mostly felt in southwestern France, in the neighborhood of the gas field. In this district, already partly served by Saint-Marcet, the supply of Lacq gas will greatly extend the use of natural gas. The fertilizer factories in the southwest will be able to raise their production substantially. A large chemical plant is to be established near Lacq by a group of French companies; this factory will use the Lacq gas for the production of ammonia, nitrogen fertilizers, methanol, acetylene, acetaldehyde and butanol. As mentioned above, the manufacture of polythenes is also to be started in this district. An electric power station is in course of erection near Lacq. It will supply cheap current to French aluminum producers, enabling them to increase their output of this metal by half, by building a new factory at Lacq (Péchiney) and raising the capacity of an existing factory in the neighborhood (Ugine). The greater part of these new works will be commissioned at the end of 1960.

Thus, the whole of the southwestern district, hitherto poor in natural resources and whose industrial development has consequently lagged behind that of the rest of France, will now enter into a period of progress and expansion.

André Blanchard



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Oil and Economics

(*Continued from page 3*)

Every year, the Institut Français du Pétrole trains 600 to 700 engineers, foremen, drillers and geologic technicians. It gives young Frenchmen facilities for study visits abroad and also teaches many young men from other countries. It is making an efficient contribution to better international understanding on the cultural, technical and scientific planes.

Day by day, the success of prospecting operations is being confirmed. After southwestern France, the whole of the Paris district is revealing its oil potential, and across the Mediterranean new petroleum fields of world importance are being discovered. Our production, now in its infancy, will very soon meet our requirements, and doubtless exceed them substantially in a few years.

It is indeed remarkable that efforts of such amplitude have been carried on and coordinated in all spheres—political, diplomatic, technical, scientific, industrial and financial. This is undoubtedly due to the fact that hard and severe as they were, these efforts never exceeded the nation's strength. Each achievement which reduced our expenditure, was also the stepping stone to further progress. A particularly striking illustration of it is that the percentage of cost in foreign currency of our supplies was brought down from almost 100 to about 35, although imports were rising to 30 million tons and our tanker fleet, and refineries were being reconstructed. Oil has therefore helped us to overcome serious financial difficulties of bringing in money to the state and reducing the nation's expenses. It has also greatly contributed to promoting the investment of savings, thereby giving renewed life to a falling financial market.

The reason why all this activity has taken place within the economic and demographic revival of France is that not only has it solved the oil problem, but opened up new fields of work to a nation which has once more become young and enterprising.

The building of a modern and powerful fleet of tankers considerably extended the activity of our shipyards. As and when our distribution network improved and extended from metropolitan France to Africa and our remote territories, commercial relations were established, giving rise to further needs for transport and services. With the increase of our refining capacity and the improved quality of our products, more and more orders were placed with our equipment manufacturers, and our foreign markets steadily expanded. At the same time, the impetus given to refining and the action of technical progress promoted the development of an industry with a great future, i.e. petroleum chemistry, which now also supplies and calls for new services. The need for prospecting plant has created entirely new manufacturing industries, led to the organization of servicing companies and given rise to a new form of activity—basic and applied research. These discoveries have been the source of further technical requirements, further improvements and even new achievements, such as the production of special corrosion proof steels developed by French steel experts. Wherever they go, oil men call for permanent labor, contribute to the advancement of economically poor areas and give new engineers not only employment, but reasons for studying and improving their methods.

Even at this early stage we believe that French crude will become the natural source of supply of the powerful oil structure which has thus been set up, and that it will enable the whole French Community to become more quickly adapted to economic and social transformation which has already been initiated.

On the European level, one of the targets which the O.E.E.C. countries had set for themselves immediately after the war has been virtually reached. Europe now has available a new source of supply in the territories which threw in their lot with hers, and this is not the smallest result of the campaign carried on since the end of the last world conflict, during the early years of international cooperation.

(*Continued on page 42*)

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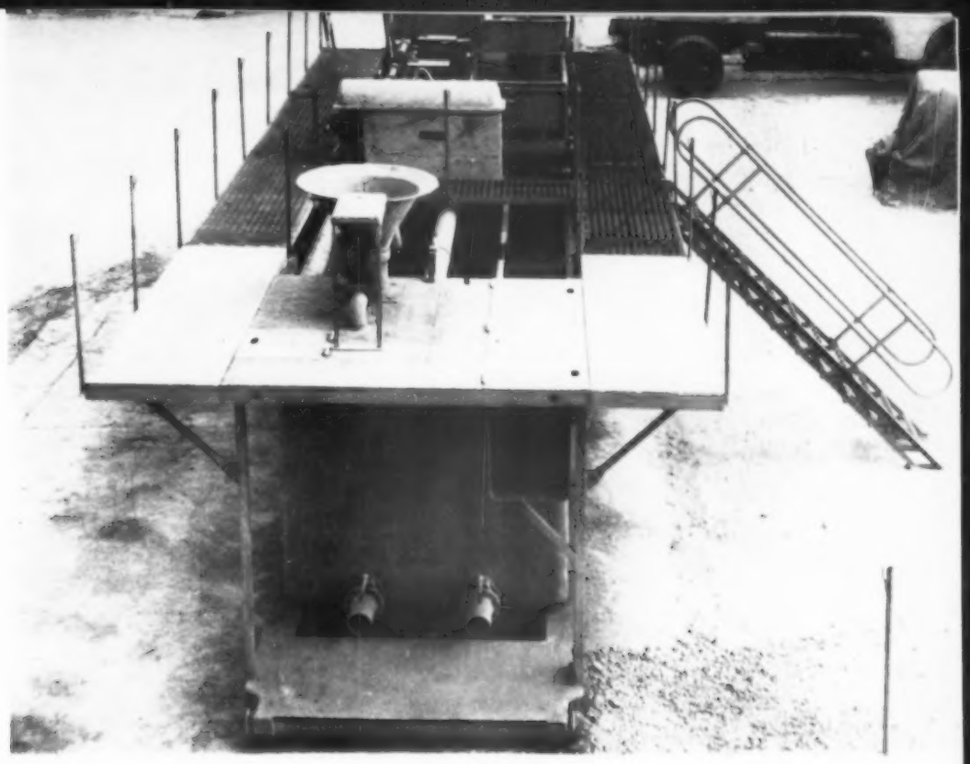


Functional Tank, showing the double vibrating screen in the background, the NEYRPIC 4-8" cyclone battery under an iron cover in the center and the 6" mud mixer in the foreground.

More efficiency and lower drilling costs

by J. Gallon, Chief of Engineering Department
of the Société Languedocienne de Forages Petroliers

The French drilling contractor "Languedocienne" has sought to improve efficiency and lower drilling costs by the scientific study of equipment, organization, drilling methods and training of personnel. The following study of the mud manifold is an example.

Drilling in various countries demands great flexibility of the drilling rig mud manifold. For instance, drilling in Hassi-Messaoud, the important new oil field discovered in the French Sahara, requires starting with a bentonitic mud having a specific gravity of 1.20, then using a saturated salt mud mixed with native clay and emulsified with crude oil having a specific gravity of 1.40 raised rapidly to 2.00, then drilling in the producing formation with an oil base mud. More than 600 tons of baryte are used, and several hundred tons of various products to combat lost circulation. A depth of about 11,000 feet is drilled to the top of the pay in less than 75 days. All mud operations, preparation, maintenance, and especially addition of products for lost circulation, have to be made in the minimum of time.

Therefore, LANGUEDOCIENNE has reviewed its conventional manifolds, and has studied them from both a theoretical and practical point of view in an experimental station in cooperation with the world known company of hydraulic engineers NEYRPIC. Results of these experiments on the new manifolds follow:

(1) *Choice of suction lines.* Theory, confirmed by experience, result in the choice of a 6" inside diameter suction line in order to maintain turbulent flow. This avoids deposits, especially of baryte, very frequent in larger diameters.

(2) *Cavitation in suction lines.* This phenomenon results in "pounding" of the pump. It is due to friction losses and the mud temperature. Experiments conducted under the most severe field conditions, sp. gravity 2.06, temperature 158 F, volume 1.060 g min, show that cavitation is never reached with 6" lines having less than an equivalent length of 66 feet. The threshold of cavitation in such conditions is 15.15 psi.

(3) *Feeding of duplex mud pump.* In case it is not possible to reduce the equivalent length of the suction line to less than 66 feet, the problem is solved by feeding the duplex mud pump by means of a centrifugal pump. This solution also has the advantage of increasing the volumetric efficiency of the mud pump to more than 95 per cent and reducing pulsation.

(4) *Mud preparation with mixer.* A mixer with 6" diameter at the bottom was designed. It is provided with a $2^1/_2$" nozzle and fed with a volume of 785 g min, giving a velocity of 66 ft sec at the nozzle, which is most convenient. It can handle 150 tons of mud products per hour, and has to be fed with a mechanical elevator (mud products in sacks) or by pneumatic silos (mud products in bulk).

(5) *Stirring the mud.* The mud is contained in 226-barrel tanks, each divided into two equal compartments, each compartment being equipped with two rolling-jets. A mud of specific gravity 2.00 having settled for 72 hours can be made homogenous in 3 minutes. This is done with 2-$1^1/_4$" diameter nozzles in each jet, and a 785 g min volume.

(6) *Desanding in the mud.* Each rig is equipped with a battery of 4-8" cyclones made by NEYRPIC. As an example, 113 barrels of mud with a specific gravity 1.20 containing 9% sand, in flowing through the battery will loose 6% of its sand in 6 min.

(7) *Moving the manifold.* The mud manifold is very compact, and designed to require a minimum number of packages when moving the rig. For instance, a heavy rig will have a mud manifold including 4 or 5 packages: one functional tank (see picture), one or two circulation tanks, one manifold on skids with all the suction and discharge lines to be connected with 3 large mud pumps and one centrifugal pump group.

Latest developments in the field of electrical measurements in drill holes

by J. L. Mathieu
Senior Vice-President Schlumberger Overseas S.A.,
Manager External relations Societe de Prospection Electrique

In order to understand clearly what has been achieved in recent years in the electrical logging field, it seems necessary to give a brief history of past development.

Before the second world war, the oil industry had at its disposal mainly two curves: natural potential (S.P.) and resistivity curve (one, then several).

The principal original use was, therefore, correlation. Many subsurface geological theories were then completely modified by the introduction of precise correlations. A very good and early example being the detailed study of salt domes and the first realization that good production could be obtained in down thrown fault blocks.

Very quickly however, it was evident that electrical logging could bring very valuable information in distinguishing between salt water sands and oil sands. Numerous unknown oil strata were uncovered through general use of electrical logging.

We may therefore say that before the second world war, the applications of electrical logging were as follows:

A. *Sands and Shales alternating or in general Soft Formation territories.*

1—Correlation.

2—Fair distinction between oil sands and water sands and eventually between gas and oil.

B. *Hard formation territories.*

1—Correlations.

2—Some localizations of pervious sections. Yet when the drilling fluid was very

(Continued on page 37)

Fig. 1. Known as "the standard" of the industry, the Electrical Log is a quick and accurate method for securing a record of the formations penetrated by the bore-hole.

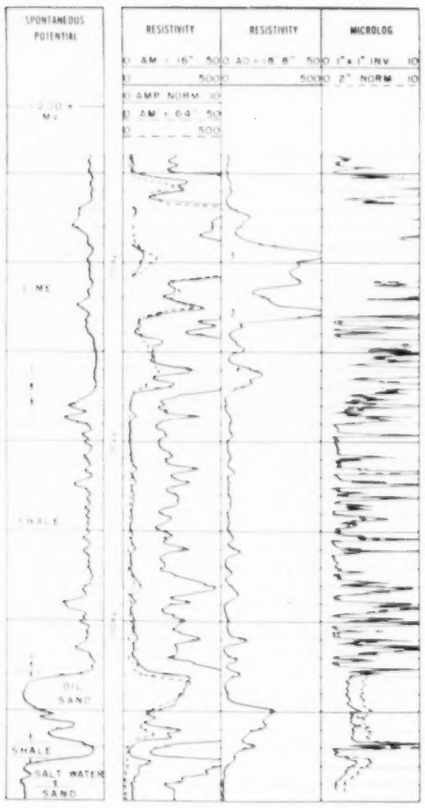
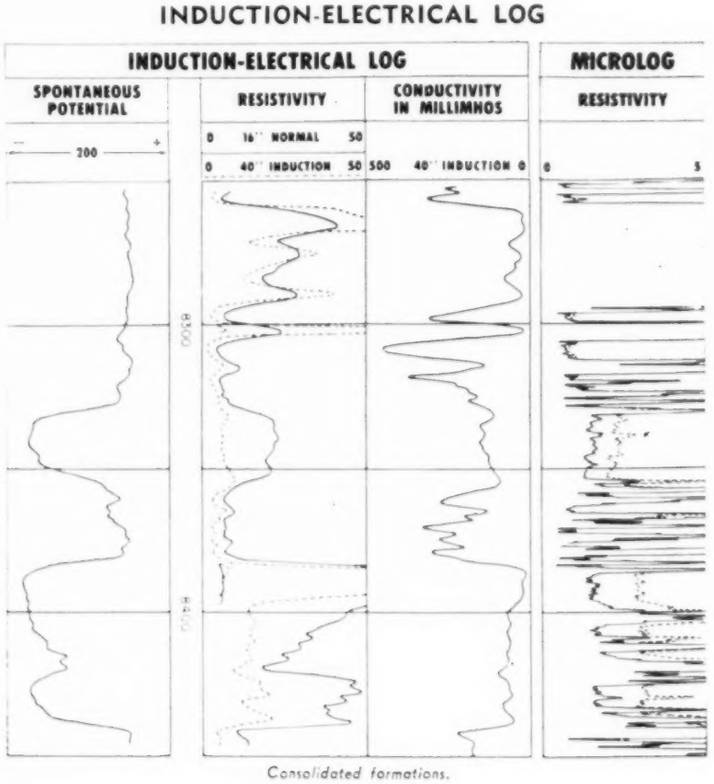


Fig. 2. The Combination Induction-Electrical Log is replacing to an important degree the conventional Electrical Log as a basic surveying tool. Its superiority is due to the incorporation of the focused Induction Log, which gives deep investigation yet retains sharpness in detail and high accuracy in thin beds.



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For all practical purposes, the velocity of a sonic wave is controlled by the formation porosity and the fluid in it.

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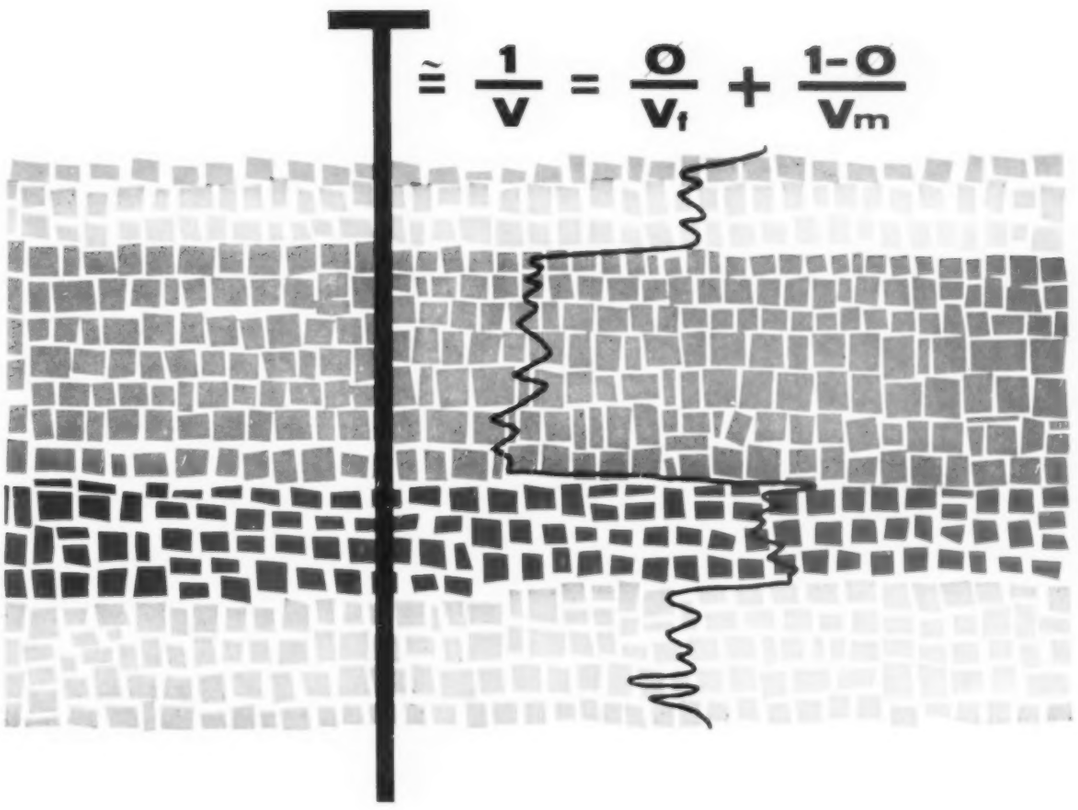

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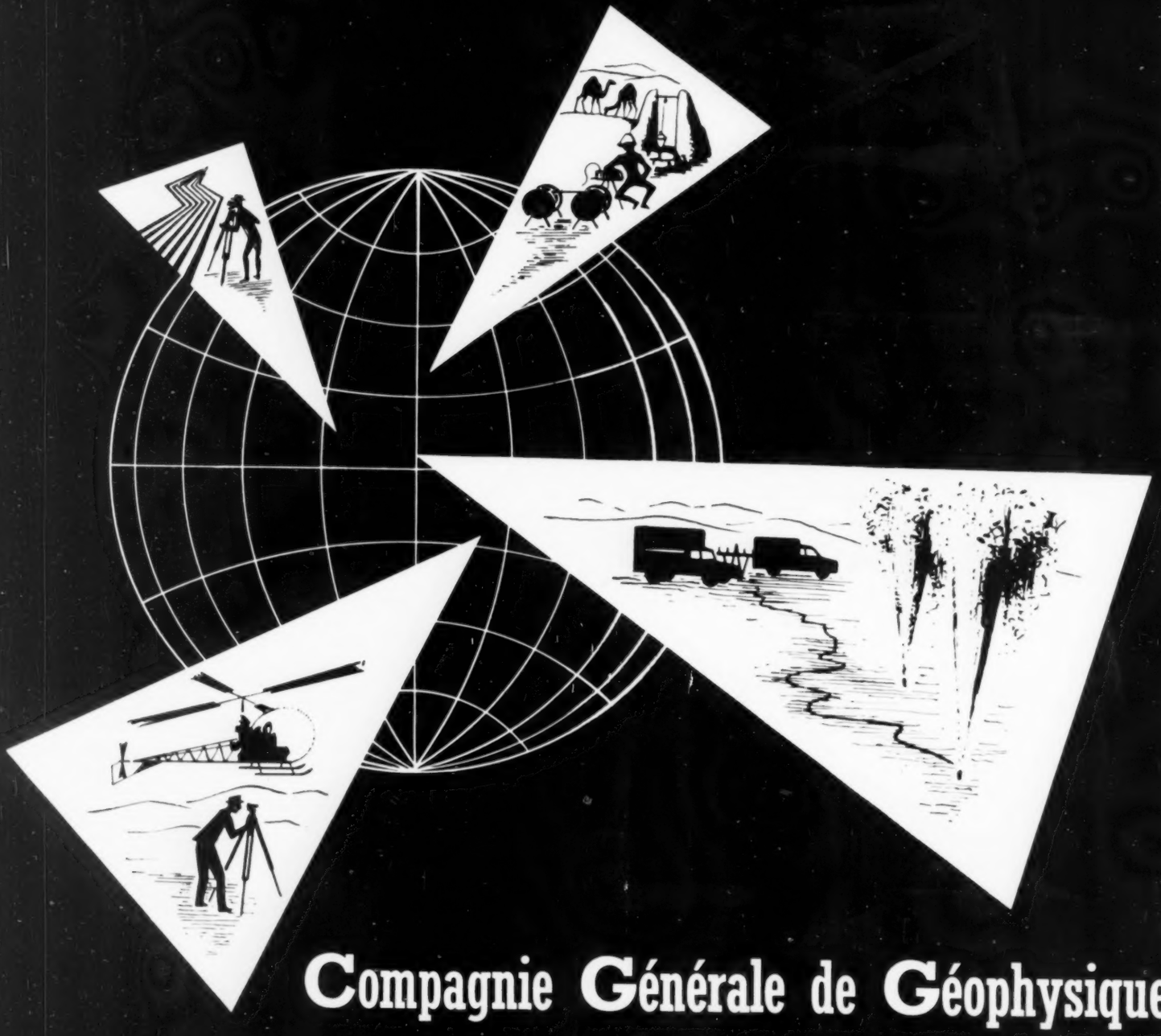

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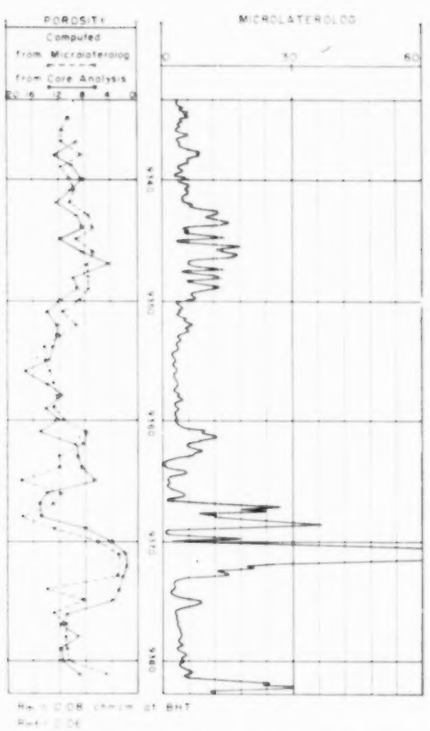


Fig. 3. The Microlaterolog is a focused logging method which measures the resistivity of the zone close to the wall of the bore-hole. The method is particularly adapted to salt-mud areas and to hard formations. It is an important component of the Salt Mud Survey.

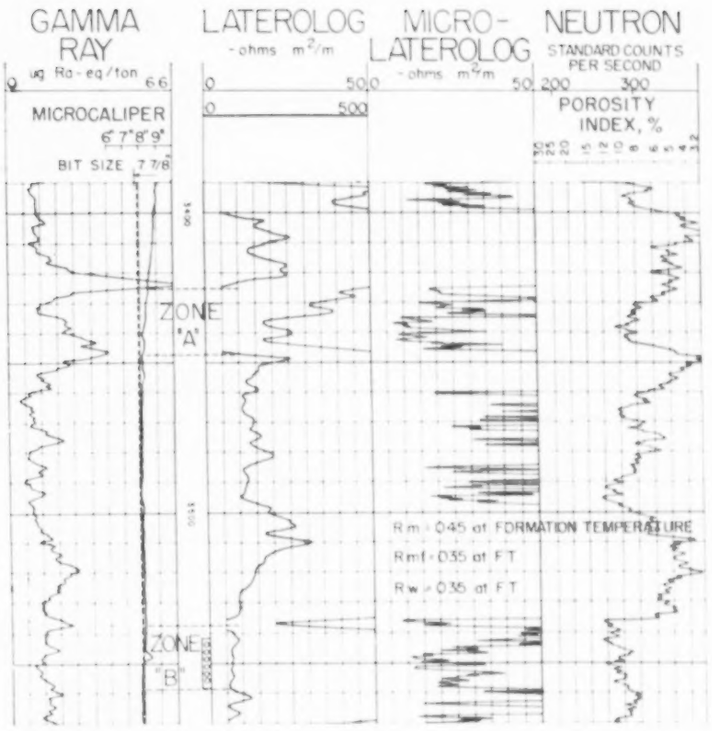


Fig. 4. For salt-saturated mud, the problem of obtaining a complete logging program is solved by the Salt-Mud Survey. The entire combination includes the Laterolog, Gamma-Ray Log, Neutron Log, and Microlaterolog. The Gamma-Ray Log is used to determine the character of the formations; the Laterolog and the Microlaterolog complement each other in identifying the possible producing zones and provide resistivity values from which true resistivity can be calculated for quantitative analysis of these zones. The Neutron curve gives a porosity index for reservoir evaluation.

salty, even the correlations became poor.

After the second world war. It was around 1939 that the theory of invastion of the permeable strata by the free water from the drilling mud made its appearance. It added considerably to the complexity of the investigation.

It was also established by laboratory experiments that the problem of Natural Potential measurements was vastly more complicated in hard formation than in soft ones.

Accordingly all the efforts of the post-war period have been made along the following lines:

A—Replace or complete the natural potential log by a new one, in order to localize accurately the permeable layers. This has been accomplished remarkably well by the Microlog.

B—Obtain direct measurements of the porosity of the permeable layers. This can always be done by one of the combinations of Microlog-Neutron Log, Microlaterolog or the very recent Sonic Log.

C—Reach an absolute diagnosis of the formation content.

This is a very-tough problem particularly in hard formations which have a low permeability and are therefore deeply invaded by the free water of the mud.

There are many varying factors such as: hole size, resistivity of the mud, resistivity of the invaded zone, diameter of the invaded zone, relative thickness of the bed to hole size, relative resistivity of the layer considered and of the surrounding beds, resistivity of Connate or Formation water, etc.

As a result it has been quickly evident that the use of several resistivity curves of the same type with increased depth of investigation was totally insufficient to solve the highly complicated problems of hard formations.

They do permit the obtaining of several points on a "Departure Curve," but they do not provide additional equations to solve the many unknown factors.

This has been accomplished only through the introduction of horizontally directed currents with focused logging. Laterlog, Microlaterolog and Induction Log were thus born.

It is worth mentioning that a correct appraisal of the formation possibilities under difficult conditions can only be done through electrical measurements, as all the other type of techniques have an extremely limited radius of investigation.

Today, except in soft formations of high permeability and high porosity, where invasion is practically non existent, the new devices are rapidly displacing the old resistivity measurements.

In Western Europe, the Americas, Africa and also countries of the ECAFE, in addition to standard electrical logging in every well.

90% of the wells use Microlog

75% of the wells use a focusing device such as Laterolog

50% of the wells use the induction log.

The last method is increasing very rapidly.

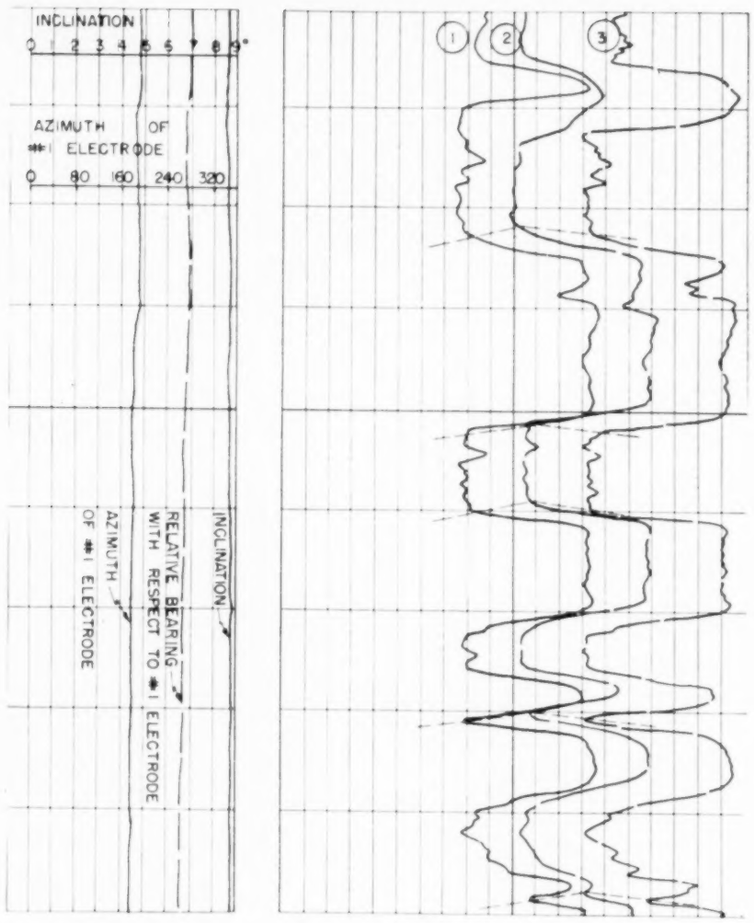


Fig. 5. The Dipmeter is a survey instrument run in the hole to determine the amount and direction of the dip of various formations penetrated by the drill. These data are of extreme importance to the sub-surface geologist in locating and mapping structures.

Section of Continuous Dipmeter Log covering 18 feet—sharp detail of the Micro-Focused Resistivity Curves gives high accuracy to dip computations.

For the first time it is thus possible to:

1. Reach the true value of the formation resistivity regardless of the conditions. (Figs. 1 and 2)

3. Calculate the formation connate water resistivity. (Fig. 4)

4. Calculate the water saturation.

5. According to the porosity value predict if, for a given saturation, oil or water or both will be produced.

Application in Salt muds. (Fig. 4). In some areas such as Kansas, the Permian Basin, and the Williston Basin many wells are drilled and completed using salt muds. The high electrical conductivity of this salt saturated mud causes it to act as a short circuit across the electrodes; therefore, a considerable part of the current applied in the conventional electrical logging system passes along the bore hole instead of into the formations. The accuracy and definition of resistivity measurements is proportionately reduced. The S.P. Curve generally lacks character due to the approximately equal salt concentrations in formation waters and in the drilling mud.

For these conditions, the problem of obtaining a complete logging program is solved by the salt mud survey. It has been used on thousands of wells to give excellent logs for both geological and reservoir study.

The entire combination includes the Laterlog, Gamma-Ray Log, Neutron Log, and Microlaterolog. The complexity of the problem determines whether all or part of the four components are necessary. It is customary however to run at least three of them. The Gamma-Ray Log is used to determine the character of the formations; the Laterolog and the Microlaterolog complement each other in identifying the possible producing zones and provide resistivity values from which true resistivity can be calculated for quantitative analysis of these zones. The Neutron curve gives a porosity index for reservoir evaluation.

Subsurface studies. For the subsurface studies, the combination of all the present logs gives so perfect a correlation that nothing can be added to it.

However one new electrical tool has brought about a new revolution in subsurface studies. This is the Continuous Dipmeter. (Fig. 5).

The oversimplification of subsurface maps which indicate fairly regular dips for one given bed, even in the case of a very regular anticline is greatly changed by a correct appraisal of the dip all along the formations traversed by the drill hole.

The Continuous Dipmeter brings the following information:

1. It distinguishes between stratified formations indicating a clear dip and the others,

2. In case of unconformity it indicates it clearly on the first hole

3. In case of deeper structures not concentric with the upper ones, the true picture becomes rapidly evident

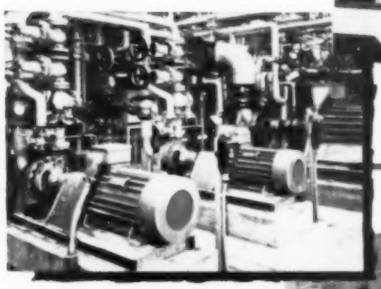
4. In complicated structures—highly faulted or saltdomes types for example—it can locate the passage of the fault through the well and help the correlations by indicating the dips of the various fault blocks as well as the dip of the fault plane. It thus prevents the drilling of many dry holes.

5. Last but not the least in wildcats, when—as it is often the case—they are drilled on the flank of the structure, instead of the top, it points to the direction of the crest.

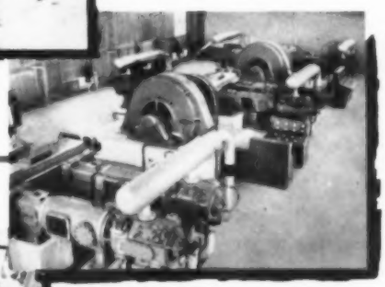
Those are the main developments in the field of electrical measurements in drill holes for the past decade

WORTHINGTON builds in Europe its petroleum equipment through its Associated Companies

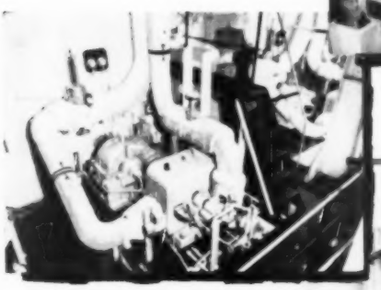
Pipe Line Station Wesel
Gelsenberg Benzin AG



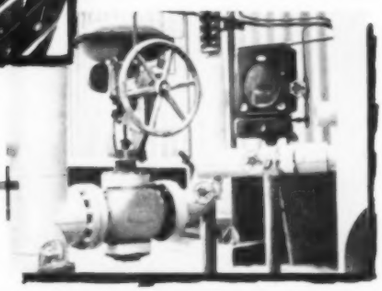
Process pumps
Esso Refinery Hamburg Harburg



Gas compressors in a natural gas plant (France)



Steam turbines driving WORTHINGTON cargo oil pumps aboard tanker



MASONEILAN automatic controls

PIPE LINE PUMPS
PROCESS PUMPS
STEAM PUMPS
POWER PUMPS
AIR & GAS COMPRESSORS
STEAM TURBINES
REFRIGERATION EQUIPMENT
CONDENSERS
AUTOMATIC CONTROLS

MASONEILAN

G 347

WORTHINGTON

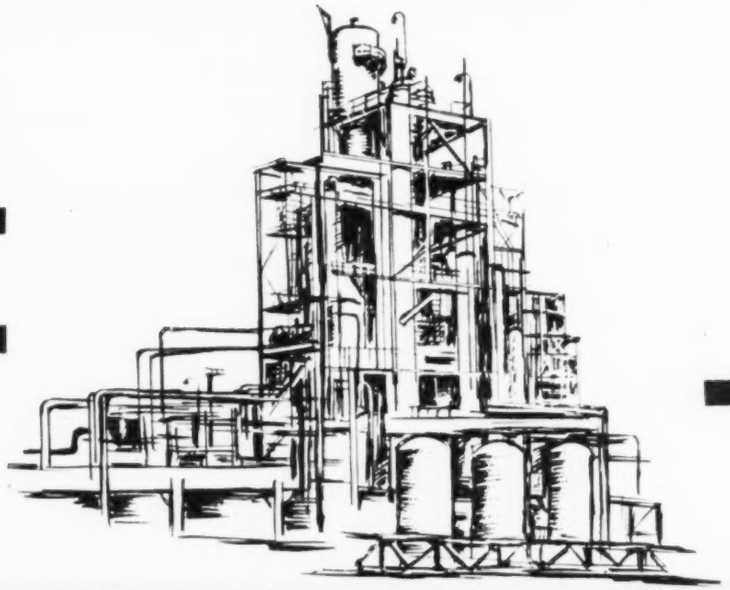
FRANCE 37, Rue de Liége
PARIS (8') - Works: LE BOURGET

GERMANY Deutsche Worthington G.m.b.H. HAMBURG

SPAIN Worthington S.A.
MADRID

ITALY Worthington Societe Italiana Pompe e Compressori MILAN

from oils...



...to chemicals

from Ethylene :

Ethylene oxide
Glycols
Glycolethers and Derivatives
Ethanolamines
Polyethylene Glycols liquid and solid form
Polyethylene (ZIEGLER) - sales by PECHINEY

from Propylene :

Isopropanol
Acetone
Isopropyl acetate
Propylene oxide
Propylene glycols

NAPHTACHIMIE

203, RUE DU FAUBOURG SAINT-HONORÉ - PARIS 8e - CAR. 64-10

Plant at LAVERA by MARTIGUES (B.-du-Rhône)

The French petrochemical industry—— from petroleum to refining and chemistry

by **Maurice Moulin, Chemical Engineer Lyon University, Chairman of the Petroleum and Natural Gas Chemistry Section of the French Association of Petroleum Technicians (A.F.T.P.)**

THE French petrochemical industry is young but highly developed. It dates back in fact only approximately ten years. It is indebted for its rapid stride to a powerful and efficient petroleum industry which, in spite of numerous difficulties, managed to successfully carry out two complementary tasks, first, increasing its refining capacity and second, searching for either liquid or gaseous hydrocarbons in both home and overseas French territories.

It is obvious, at all events, that France, which after World War II, had to build up again and develop its refining capacity, and whose territory was, so to speak, strictly void of crude oil and natural gas fields, could not dream of ever launching itself into this new petrochemical industry without first having secured the refining capacity its overall economy required.

At a later stage only, when faced with the ever increasing demand from a chemical industry in full expansion, it was led, in order to meet the requirements of petrochemistry, to use such facilities as catalytic cracking and reforming units which had originally been designed primarily for improving motor fuel quality. By operating these facilities and, later, steam cracking type units, more specifically designed for petrochemistry, the basic hydrocarbons required by the development of this industry were produced, then used either by the petroleum industry itself or by the chemical industry in the production of first intermediate then still more elaborate chemicals used by quite a number of industries, the main ones being the following:

Plastics and synthetic resins
Paints and varnishes
Synthetic rubbers
Synthetic textile fibers
Synthetic detergents
Agricultural products and fertilizers
The oil industry.

It may be worthwhile, also, to point out that the French coal industry, that had made rather substantial progress after the last war, seems to have now steadied at around a yearly production of 60 million metric tons, which is far from being enough to meet the French chemical industry's increasing needs. Quite the opposite, as is evidenced by figures shown in the following tables, the French oil industry's effort has been very sustained, and there is every reason to believe that it will be continued, with respect to both exploration and refining.

French coal production
(Thousands of Metric Tons)

1938	47,562
1952	57,355
1953	54,536
1954	56,315
1955	57,388
1956	57,381
1957	59,087
1958	60,200

French natural-gas production
(Thousands of Cubic Meters)

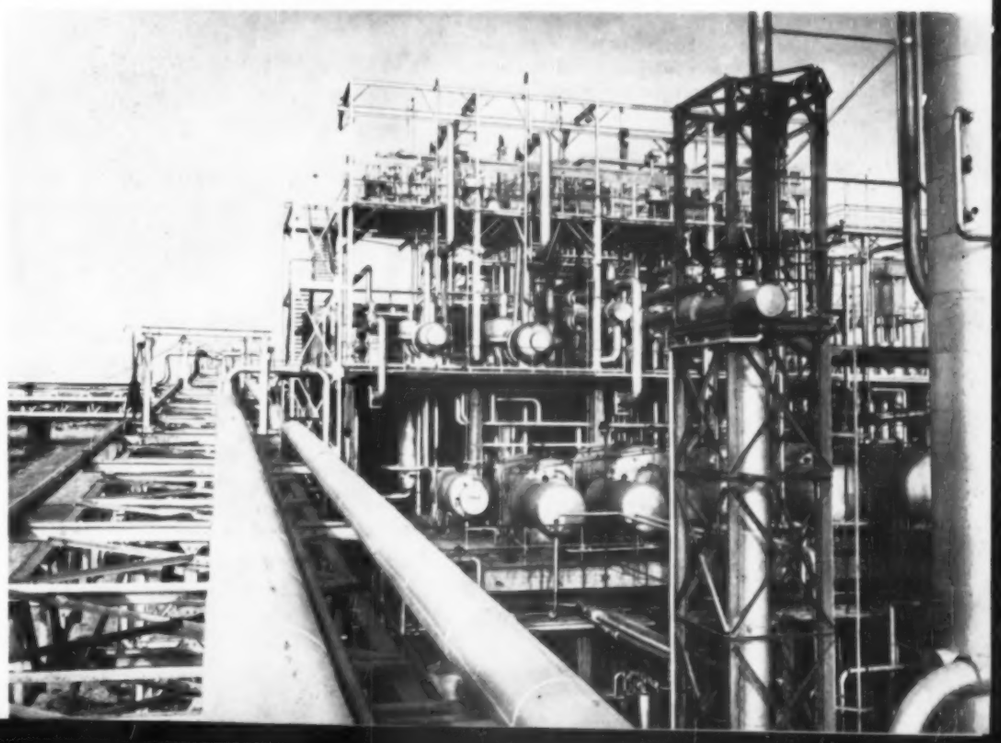
1938	Nil
1952	266,500
1953	244,500
1954	259,100
1955	266,350
1956	319,400
1957	552,795
1958	1,045,789

French crude-oil production
(Overseas territories included)
(Thousands of Metric Tons)

1938	72
1952	349.8
1953	367.6
1954	508.5
1955	875.1
1956	1,263.6
1957	1,680
1958	2,408

(Continued on page 49)

Naphtchimie. Lavera plant—manufacturing unit of ethylene oxide.



Contributions of The Institute Francais du Petrole to the Petroleum Industry

(Continued from page 6)

and in the study of uses of petroleum products at the National Engine Testing Station, of which the Institut Français du Pétrole has undertaken the reconstruction with the most modern equipment.

These laboratories and departments give invaluable assistance in training executive, engineering and key personnel at four centers for higher studies:

Center of Advanced Studies in Geological and Geophysical Exploration.

Center of Advanced Studies in Drilling and Production.

Center of Advanced Studies of Refining and Chemical Engineering.

Center of Advanced Studies of Internal Combustion Engines and Applications of Petroleum Products.

The four are grouped within the framework of the Institut Francais du Pétrole at the Ecole Nationale Superieure du Petrole et des Moteurs.

The curriculum of these centers comprises essentially advanced practical and applied instruction for young engineers who have already graduated from a university or one of the well-known higher schools of engineering. They are now attended yearly by 300 young students, who come into contact at the Centers with some fifty foreign students belonging to 15 different countries.

The institute's teaching activities have now been extended to training skilled specialized workers such, for example, as tool pushers, drilling site foremen, refinery foremen, project engineers and draughtsmen, maintenance experts, etc.

Thus, 500 technicans are now attending our various sessions each year.

Numerous arrangements are made to complete this training continuously throughout the careers of those concerned. This is done in many ways, such as: refresher courses in the organizations of the Institut Francais du Pétrole itself; demonstrations of new techniques in the field; organization of directed study visits in France and foreign countries, the students taking direct part in the work, etc.

It is thus seen that a very highly diversified range of facilities is brought into play, intended to serve as a tool available to all, at all stages, to enable them to improve their knowledge and their skill in putting that knowledge to the best use.

The 800 men of all ranks and ages who thus attend our training establishments each year are in close contact with the 1,200 technicians of the Institut Français du Pétrole. For almost 15 years now they have learnt to appreciate how recourse to fundamental knowledge can hasten the acquisition of experience and of the ability to use that experience daringly and reliably to solve new problems.

It is to the high quality of the methods and processes developed or proved in our laboratories and engineering and designing offices, to their wide spread demonstration

(Continued on page 64)

Aerial view of Institut Français du Pétrole

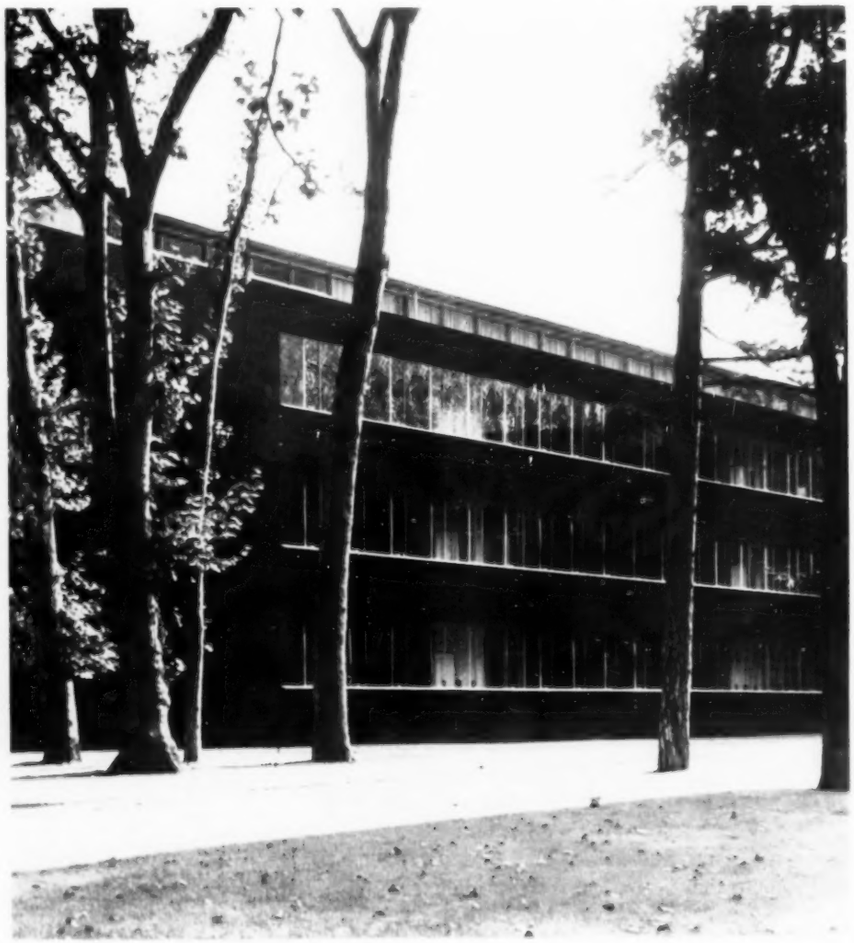
Oil and Economics

(Continued from page 31)

Results are certainly gratifying and the new tasks before us can legitimately be assumed with deep feeling and enthusiasm.

But having reached the threshold of success, we should give thought to its causes. We must first recognize the value of the teaching received from those who preceded us on the road to these great achievements. This teaching was applied and adapted to the concepts and methods peculiar to France, and results were initiated, built up and consolidated without disturbing the complicated play of competition and world trade. Our "coming of age" in the oil industry has been peaceful and has not given rise to any depression. It is a good example of international cooperation which can certainly still be applied wherever difficulties exist. This is why our geologists, engineers and technicians, economists and contractors can make their experience available to all who may ask for it. Their record, built up during the last ten years, under exceptional difficulties and when their initiative was frequently disapproved of by others, is a very fine one. They have gained their mastership and experience by the force of arms in this industry which, in spite of its youth, is in touch with all styles of life and all peoples, does away with routine and suggests future progress. If, as we can be sure, the early future shows that French oil production can take its place among the first in the world, few will be the cases where we shall not be able to relieve distress by contributing our oil to aid in economic expansion.

END



One of the Institute's modern buildings

GAS PIPING NETWORKS IN FRANCE

by Pierre Courtet
General Comptroller of Gaz de France

Gas piping networks, and particularly the high pressure networks which permit large quantities to be transported at low cost have, like everywhere else in the world, been developed rapidly in France.

This growth is the result of the development in gas resources which, in France, has its own characteristic aspects. It would therefore be of interest to briefly recall these characteristics, it being at the same time borne in mind that the largest recent piping systems now deal with natural gas, but that sizeable networks still exist for conveying coal gas or refinery gas the harmonization of which with natural gas raises complex problems.

French achievements in the field of large gas piping networks (conduits, compression systems and underground storage reservoirs) have found inspiration both from specifically French studies initially based on coal gas, and from a knowledge of foreign, and especially American, achievements.

I. Development of high-pressure networks

Before schematically illustrating the development of networks by means of their 1946 and 1958 charts, we wish it to be remembered that the development of high pressure systems was initiated in 1922, first in the northern region to evacuate the gas from mine coking plants, and later around certain large towns, Paris in particular.

A pressure of 60 kg/cm² (about 900 psi), was first used by the "Regie Autonome des Petroles" in France, to convey this gas towards neighboring utilization centers and as far as Bordeaux, following the discovery of the natural gas strata at St. Marcet. This network was built between 1942 and 1950.

The 60 kg/cm² pressure was first used with coking-plant gas in the Lorraine-Paris pipeline installed by Gaz de France during 1952 and 1954. The gas collecting network in Lorraine had previously been laid by Gaz de France with a pressure of 47 kg/cm² in view. This kind of performance was entirely new, having regard for the specific difficulties attached to coking plant gas.

A. *Situation in 1946 and trends at the time:* The development of networks in 1946 is shown on the accompanying chart (Fig. 1).

The post-war trend immediately following 1946 could be characterized as follows:

(a) The number of factories in poor condition as the result of war damage and difficulties, favored the tendency towards a concentration of production means notwithstanding the fact that various attempts were made to make use of lighter production methods such as gasification of coal and petroleum oils and the utilization of propane, etc. Liquefied petroleum gases revealed themselves to be a means of solving the problem of isolated small plants.

(b) The natural gas piping network of the southwest region was developing rapidly.

(c) However, the most noteworthy fact was the development in the production of coke for the steel industry in France, this entailing the modernization of mine and steelwork coking plants in the northern, eastern and central regions, and of gas producing coking plants in Rouen, Strasbourg and the Paris region.

As a result, large quantities of coking-plant gas became available. In addition, the northern piping network began to be developed. About this time, the main eastern pipeline for collecting gas from the coking plants in the eastern region and distributing it through the northeast of France and conveying it to Paris was completed. Furthermore, a smaller piping system was built in the central region.

(d) Development in the refining of crude oil left available quantities of non-condensable residual gases which were piped and used for the partial or total supply of power to the Seine Maritime region—which is connected to the Paris region—to Bordeaux and especially to the zones in the Mediterranean region.

To summarize; the period under consideration was characterized by the utilization of all gases available thanks to long distance pipelines, and also by the fact that gas production based on liquefied petroleum gases and, where necessary, on petroleum oil gases, made it possible to solve the problems of isolated small plants which it was not an economic proposition to link up to a pipeline.

B. *The Situation in 1958 and Current Trends:* The network in 1958—partly in service and partly under construction—is shown on the accompanying chart No. 2 which illustrates the general extension effected since the position in 1946 (shown on the 1946 chart), the main new pipelines being those conveying the coking plant gas from the east to Paris (with an underground reservoir at Beynes near Paris) and those piping the natural gas from Lacq across the country (with an underground reservoir at Lussagnet, near Lacq, and another underground reservoir, if required, at Vernon near Paris).

These pipelines will serve to supply France with gas in the following way in the very near future:

(a) A large zone including north and eastern France utilizes as its basic gas the gas derived from the coking plants in the north, the east, the Paris region, Strasbourg, Rouen and Caen.

A large complement of natural gas is to be conveyed to Paris, and refinery gas is also to be received in the Seine Maritime region, these latter gases having to be reformed to make them similar to conventional gases (coal gas, carburized water gas, various additives).

The various regions in this zone are provided with very dense piping networks, so that very few isolated plants remain. Though these regions are not yet linked together, such a link-up seems certain in the near future. At present the Seine Maritime, Paris and Lorraine regions form an

entity which is soon to be linked with the Ardennes. These regions, together with the northern region, are ceaselessly extending towards one another. The linking up of Caen with this group is probable and only that involving the Alsace region—which is isolated by the Vosges—appears to be less imminent. This zone is furthermore connected at two points to Belgium, and at another two points to the Saar region. Though the gas used in this zone is conventional gas, it is not impossible that natural gas may make inroads there.

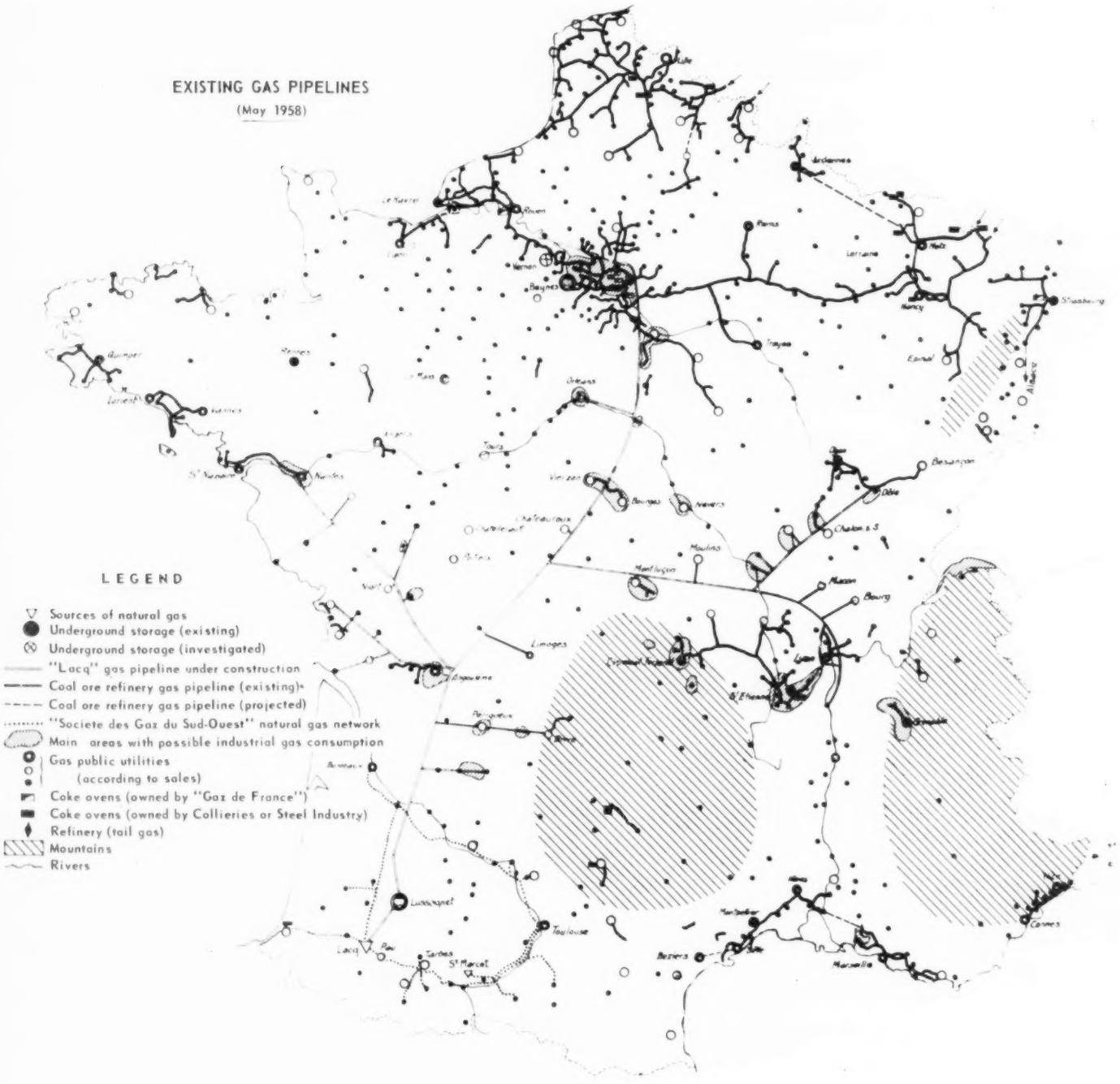
Another large zone is establishing itself around the pipelines conveying natural gas from Lacq which is due to replace the gases currently being produced. At the same time, this is a zone which is developing lengthwise along the pipelines and which leaves large gaps which are not reached by the natural gas conduits.

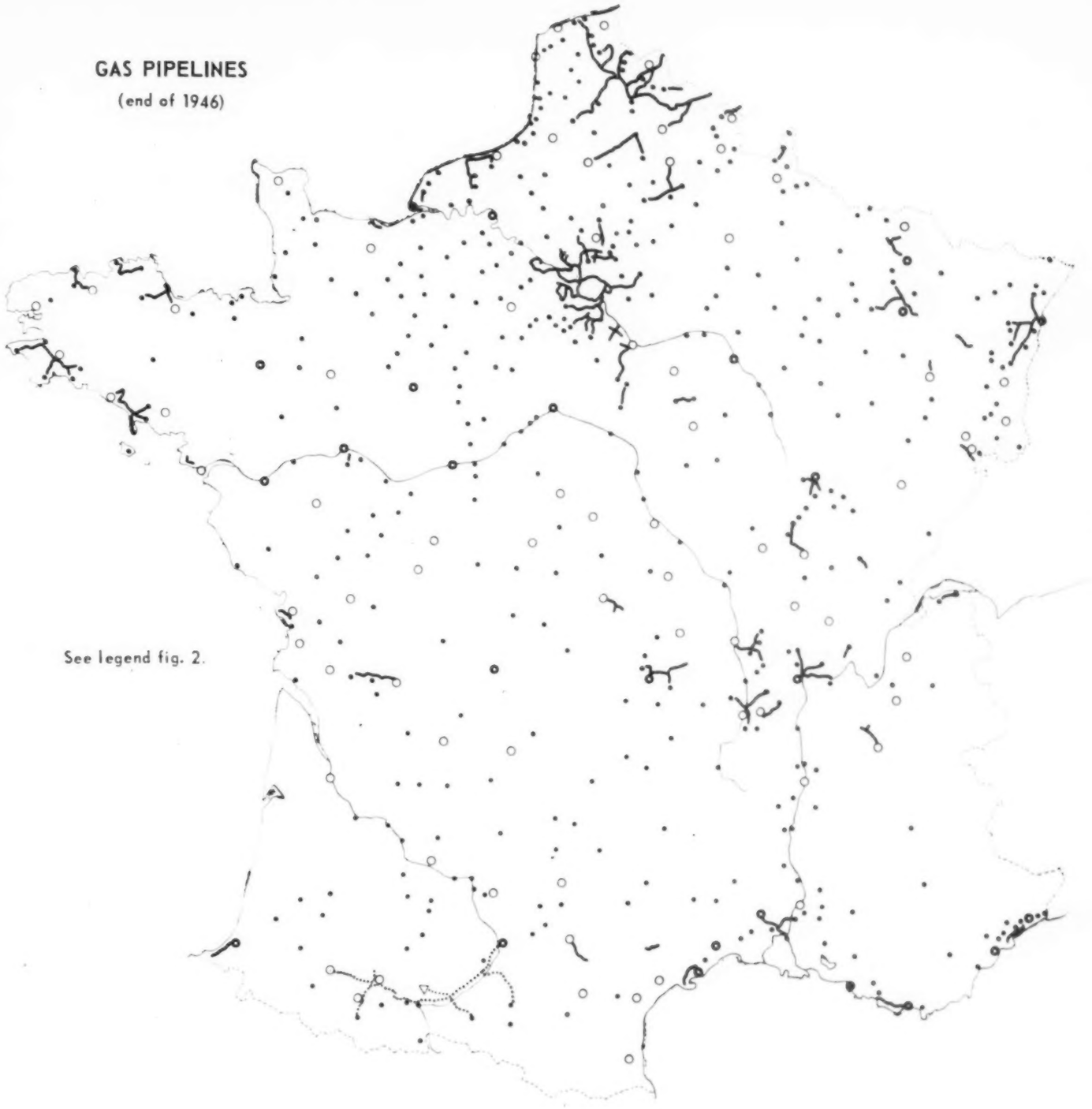
Fig. 2 shows the various areas served by natural gas, which seems destined to make progress towards the center and the southwest coast of Brittany.

If natural gas resources increase, it is likely that it will be called upon to supply the whole of the Loire Valley and the new pipeline running between Angouleme, Tours, Le Mans and Rouen. A large coking plant exists in the St. Etienne region, and its production will be absorbed by St. Etienne and its immediate surroundings, while natural gas will take over on the periphery of this region.

(c) Non-condensable refinery gases supply a whole region which encompasses a large part of the French Mediterranean coast.

(d) Besides the large zones which have just been mentioned, there is an appreciable number of plants which cannot be





See legend fig. 2.

linked to the planned feeders because consumption and their distance from the network do not justify transport of the gas. These are the plants which we have called "intervening" plants.

Apart from specific cases such as the large Nice-Cannes group, these are small or medium size plants production of which, in the case of the latter is around 5 million cubic meters (at 4,500 kcal/Nm^3) per annum and which, under exceptional circumstances, can reach 10 million cubic meters a year. It is indeed only seldom that the largest of the plants are not close enough to one of the existing or projected piping networks and that their consumption does not justify a link-up which will in any case be effected at the very latest when the plant has to be renovated.

C. *Future Development:* Future development will essentially depend upon possible bulk resources of natural gas available later, by way of: Increased production from the Lacq gas strata, fresh discoveries of natural gas on home soil, and the conveying to France of Sahara gas.

Prospects in this connection are favorable enough to have led M. George Combet, Director General of Gaz de France, to evaluate French consumption in the year 2000 at 500 billion therms of gas (475 billion being natural gas), whereas in 1956 this consumption had attained only 22 billion,

of which less than two were accounted for by natural gas[1].

II. The Administration Set-Up

Before 1946 gas piping in France was subject to virtually no overall administrative regulations. Carriers merely had to obtain rights of way which were granted by the bodies in charge of the communication lines followed or crossed by carriers (roads, railways, navigation lines). At that time, as a matter of fact, gas pipelines often followed the same path as roads, whereas now they run in a much more direct line across the countryside.

The law of April 8, 1946 nationalized the transport of all fuel gases in France, and entrusted transport management to a public and national establishment with an industrial and commercial character known as Gas de France. A law promulgated on August 2, 1949 has since excluded from this nationalization the transport of natural gas as far as the input meter of the power distribution plant, it being stipulated, however, that such transport must nonetheless be effected by a public concern, or else by a national company in which the state owns the major part of the holdings. Alternatively, the majority of the holdings have to belong to a public body.

In practice, apart from the natural-gas network of the southwest region, almost all of current French gas networks, including the Lacq gas network outside of the southwest region, have been built by Gaz de France.

Lastly, a decree dated August 30, 1951 has laid down the process whereby the State can intervene to grant or withhold permission to build or operate a piping network. Depending upon their size, networks are in operation either under a regime of concession or one of authorization, for which formalities are simpler.

A standard specification has been approved by a decree dated January 15, 1952, in respect of concessions for the long distance transport of gas by feeders.

The minister responsible for gas matters receives applications for concessions; the latter then become the object of enquiries in the regions concerned, following which a report is made out by a centralizing chief engineer. The minister will pass the act of concession after due consultation with other ministers concerned.

The minimum delay which elapses between filing of the application for a concession and the beginning of work is of the order of two to four months, this including the delays ascribable to the various legal formalities which are in addition to the normal delay required to obtain the concession.

The problems raised by the discovery of natural-gas at Lacq brought about the creation, at the end of 1956, of an official body; this is the "Comite d'Etudes et de Coordination" (Study and Coordination Committee) in charge of matters pertaining to the use of gas derived from Lacq; this committee is also responsible for studying, in cooperation with the various responsible bodies, problems connected with this particular gas, for proposinng such measures as may be called for to the government and for coordinating and expediting, if necessary, measures taken by the government. This body is backed by specialists who use the latest methods of operations research.

Lastly, problems raised by the Sahara oil and gas gave rise, in 1958, to specific regulations to cover the transport of liquid or gaseous hydrocarbons in Algeria and the Sahara, and also to the creation of specialized study bodies.

III. Technology

Technology, which is always striving to obtain the lowest possible cost price, has been able to move forward within the permissible limits laid down by the safety regulations. Great strides thus became possible following a decree in September 1957 authorizing effective use of high yield strength expanded steel tubes (Standard x 52 for the main Lacq feeder). Welding methods, as well as those applied to provide internal and external protection are constantly being improved upon.

Pipe laying is now usually carried out in a straight line across country, and no longer along the roadside; where large workings (known as "circus") are involved. Pipes are laid at the rate of over one kilometer per day, special equipment worth at least 500 million French francs being used for each cirque, in conjunction with a total power output of 8,000 hp.

The characteristics to be imparted to the gas for transport purposes call for special processing in order to eliminate harmful ingredients, and in particular: (For coke-oven gas) water, hydrogen sulfide, cyanogen, naphtalene, nitrogen oxides and dusts; (For natural-gas from Lacq) water and hydrogen sulfide.

Recent compressing stations have been equipped with piston-type compressors driven by electric or gas motors; however, comparisons made in each case with centrifugal compressors and gas turbines create the assumption that this latter type of equipment is likely to find its place in the massive transport of natural gas at low cost.

The use of Go-Devil pistons and cathode type protection is now general.

IV. Economic Studies

(a) *Operation.* The interlinking of networks and the use of underground storage reservoirs has highlighted the role of gas dispatchers, who exercise authority not only over the piping network, but also over all production sources of basic and peak time gas; this naturally requires agreements to be reached with producers, and also the laying down of a program to be followed as closely as possible, so as to obtain the best possible overall economic results.

(b) *Equipment.* Notwithstanding the latest statistical and operations research techniques, problems connected with equipment—which call for more or less long term forecasts—remain, in a large measure subject to a purely intuitive assessment. They vary in nature according to the hierarchic level from which they are examined. From the point of view of work executed in France, it is impossible to make the following distinctions in the current organizational set up:

The executive level, which receives, together with the appropriate credits, the order to establish, under the most advantageous conditions, a "gas" link between a given number of points to handle a given mass flow under given modulation conditions. Thus, this level mainly deals with technical matters.

The design level, from the "gas" standpoint.

The design level, from the "energy" standpoint.

The design level, (on the national-organization plane) which redistributes national resources (chiefly labor and finance) in terms of availabilities and national needs.

The national bodies are in any event compelled, in certain respects at least, to take into account the international situation in respect of resources and needs. International movements of coal, oil and soon gas, are the basis of a country's industrial power activities.

Insofar as gas transport equipment problems are concerned, the technical bases accepted by all countries are substantially identical, particularly as regards loss-of-charge formula. On the other hand, widely differing solutions adopted may result from different economic conditions (cost of equipment, availability in pipes and pipe laying organizations, financial conditions).

Calculations made by specialists in many European countries in respect of transport operations involving comparable quantities and characteristics have led to the adoption of diameters ranging from 400 mm in France to 600 mm in Belgium and in Germany, and extending up to 800 mm in Italy; however, notwithstanding these differences in diameter and others involving re-compression ratios and methods, ultimate discrepancies in operating costs are but slight.

Be this as it may, preparatory work connected with a high capacity feeder entails complex studies conducted by teams of specialists provided with every possible facility.

Conclusion

The long-distance—and hence high-pressure-piping of gas is of relatively recent date in Western Europe. Before the war, the French gas industry had already familiarized itself with very high pressures (300 to 400 kg cm^{-2}) by the use of bottled coal gas for traction purposes. Later, it had to solve the complex problem of transporting coal gas at a pressure of 60 kg, and this in turn led to a highly developed technique in gas processing.

In the case of natural gas, technical problems were of a simpler nature (except for the specific instance involving the purification of the sulfurous gas from Lacq); but the vast quantities available today raise a number of economic problems, and chiefly that of peak periods, which will continue to haunt the studies undertaken by all those who will have to achieve them for a long time to come.

[1] These figures do not include: producer-gases which can be transported economically only over short distances (blast-furnace gases, underground gasification gases) internal consumption by the gas, coal, steel and oil industries or liquefied gases (propane and butane) supplied to consumers in bottles or reservoirs.

Inside view of a pumping room of the Le Havre-Paris pipeline.

Managing Director of Sté Trapil
by André Genthial, President

The Pipeline In The French Petroleum Industry

After the second world war, when France had to envisage the reconstruction of her installations, petroleum refinery equipment and distribution system that had been destroyed, every endeavor was made to revise ideas that had led to the choice of some particular equipment in the light of the most recent international achievements. It was thus that we were led to consider the eventual use of a long distance pipeline. The refineries being located near the sea ports, the problem of a long distance pipeline for crude did not arise. On the contrary, consumption in the Paris region representing more than a fifth of total national consumption, it appeared interesting to envisage the construction of a products line between the port of Le Havre and the refineries of the Lower-Seine on the one hand and the depots of the Parisian area on the other hand.

Thus it was that the construction of the Le Havre-Paris pipeline was undertaken, and brought into operation in 1953.

As it appeared suitable that the pipeline undertake transport requests emanating from any Company and that it had the status of a common carrier, the construction and operations were confided to the TRAPIL Company in which the French government has a certain number of shares.

The problem that required solving was particularly complex as it concerned an adaptation to the special structure of the French petroleum industry which imposed individual deliveries to numerous depots belonging to various companies.

These depots were grouped on the basis of geographical regions, and, at the optimum side of the region, a terminal was installed for the replenishment of the region depots, with special lines connecting the terminal to the depots it was meant to feed.

The line is 250 kms. long, has a 10" diameter. It is capable of transporting a maximum of 2,200,000 tons per year. Whereas, there were only four pump stations to begin with in the immediate vicinity of the refineries source, two other long distance control stations have since been constructed that have helped increase the throughput.

The pipeline is capable of transporting a large number of various products by virtue of automatic operations, precautions taken for quality and quantity control of products, use of volumetric meters and perfected procedures in dispatching.

It is thus that this pipeline presently transports more than 30 different products, namely: three aviation gasolines; two jet-fuels; six high-grade gasolines; nine ordinary fuels; one kerosine (lamp oil); six diesel fuels; four heating fuels; one light fuel oil.

The tonnage transported has in reality increased each year and will very likely reach 1,700,000 tons in 1959. This figure results from the maximum use of its capacity during the winter but which, in summer, cannot be maintained as a result of a drop in consumption during that period.

By the precision and flexibility that operations have been able to obtain, the Le Havre-Paris line has been able to adapt itself to a complex distribution structure and to offer its clients faultless service.

The recent discoveries of oil fields at Edjele and Hassi-Messaoud in the Sahara have put new problems to France. The routing of Sahara production towards the sea has necessitated the construction of two pipelines—of large diameter—that are in the course of being laid. French Industry has accomplished an exceptional effort on this occasion both for the providing of pipes welded along a generatrix, of which the manufacture has just been perfected, and the laying of the line with the aid of transport equipment specially adapted to the desert, the best known example being a truck on exhibition at the Tulsa International Petroleum Exposition.

The work and life of personnel in the Sahara has been more particularly resolved in the most satisfactory manner.

The 24" Edgele Pipeline is 778 kms. long of which about 700 kms pass through the desert zone. The esimated annual throughput is about 5 Million tons for the start of operations but this may be increased to 17 Million by the installation of supplementary pump stations. An extensive part of the route lies in Tunisian territory and the shipping terminal is located at La Skirra in the Gulf of Gabes where tankers will be loaded by means of a sea line.

As to the Hassi-Messaoud line, it has a diameter of 24" for 533 kms. and 22" for 127 kms. The estimated annual throughput for the start of operations is about 5 Million tons that may be increased to 14 Million tons by the installation of supplementary pump stations.

The shipping terminal is located at the Port of Bougie (Algeria) where a depot is under construction, with an initial capacity of 160,000 m³ that may be increased to 384,000 m³ in the future. Tanker loading will be carried out in the outer harbour of Bougie where wharves are being constructed.

In the Metropole, as has been pointed out above, the refineries are located near the ports so that the problems of long distance crude lines for France do not arise. However, the construction of a high capacity of refining has been envisaged at Strasboug within the framework of the European Common Market. The supplying of these refineries by pipelines imposes itself and the project for a pipeline from Marseille to Strasbourg has been taken into consideration by the French Government. This 700 kms. pipeline could have annual throughput rising to 30 Million tons.

TRAPIL has been charged with the construction and operation of military pipelines on behalf of the French Government by virtue of legislative arrangements. Personnel in engineering will be absorbed by the "Omnium Technique des Transports par Pipe-Line (O.T.P.)", a subsidiary of TRAPIL, that will follow up studies undertaken by TRAPIL, who has been led to collaborate on the projects and construction of the three crude pipelines described above.

France possesses a specialized and experienced office, liable to work for the benefit of new projects which would prove necessary.

Thus, therefore, with all these projects under study or in the course of being realized, the French petroleum industry is preparing, at the dawn of the European Common Market, the means of massive transport allowing to place at the disposal of the European economy ever increasing quantities of petroleum products necessary for the work and the welfare of everybody.

Pumping station—Le Havre-Paris

THÉVIGNOT

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Valve Makers since 1906

LUBRICATED PLUG VALVES

150 to 900 lbs.

French Petrochemical Industry

(Continued from page 41)

Crude-oil tonnage processed in refineries
(Thousands of Metric Tons)

1938	6,978
1952	21,493
1953	22,647
1954	23,838
1955	25,086
1956	26,802
1957	24,965[1]
1958	29,788[2]

[1] Decrease due to the Suez crisis.
[2] For a 35,545,000 mt existing refining capacity.

In the light of these figures, it is beyond doubt that, in a country the population of which numbers 44,788,100 inhabitants, the French Refining Industry stands in a good position, at present, to ensure the indispensable development of the French petrochemical industry, the more so since in the past few years, sizeable proven reserves of natural gas and crude oil have been discovered in both home and overseas French territories. Among these, the largest that may be mentioned are:

- Natural gas
  - Lacq (home territory): 200 billion m^3.
  - Hassi R'Mel (French Sahara): 1,600 billion m^3.
- Crude oil
  - Hassi Messaoud (French Sahara): 280 million mt.
  - Edjélé (French Sahara): 125 million mt.

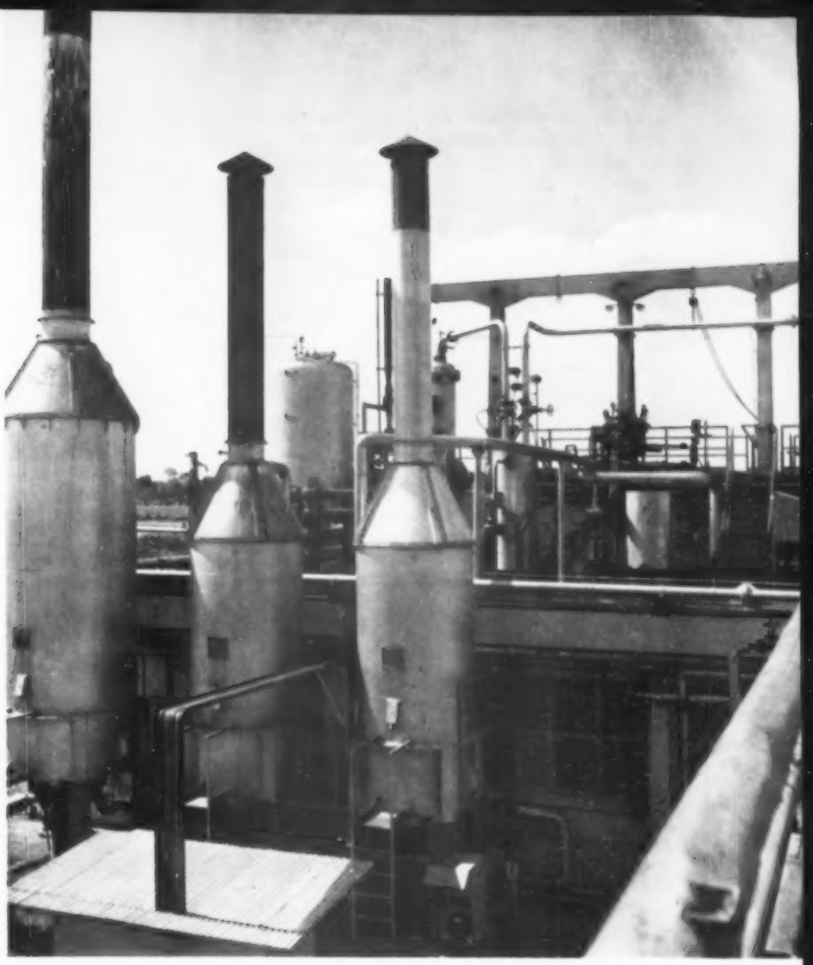
I—Petrochemistry's Oil Processing Equipment Facilities

As mentioned above, this equipment consists in catalytic cracking and reforming, and steam cracking facilities. The former permits producing mainly such olefins as ethylene, propylene and all the butenes, the latter giving large quantities of such aromatic hydrocarbons as benzene, toluene, ethyl-benzene, and the xylenes; lastly, the latter two, which are best adapted to the requirements of chemistry, permit producing, in addition to olefins, large quantities of such diolefins as butadiene, isoprene, cyclopentadiene, as well as sizeable amounts of aromatic hydrocarbons.

These facilities are listed below with their capacity expressed in terms of fresh feed tonnage:

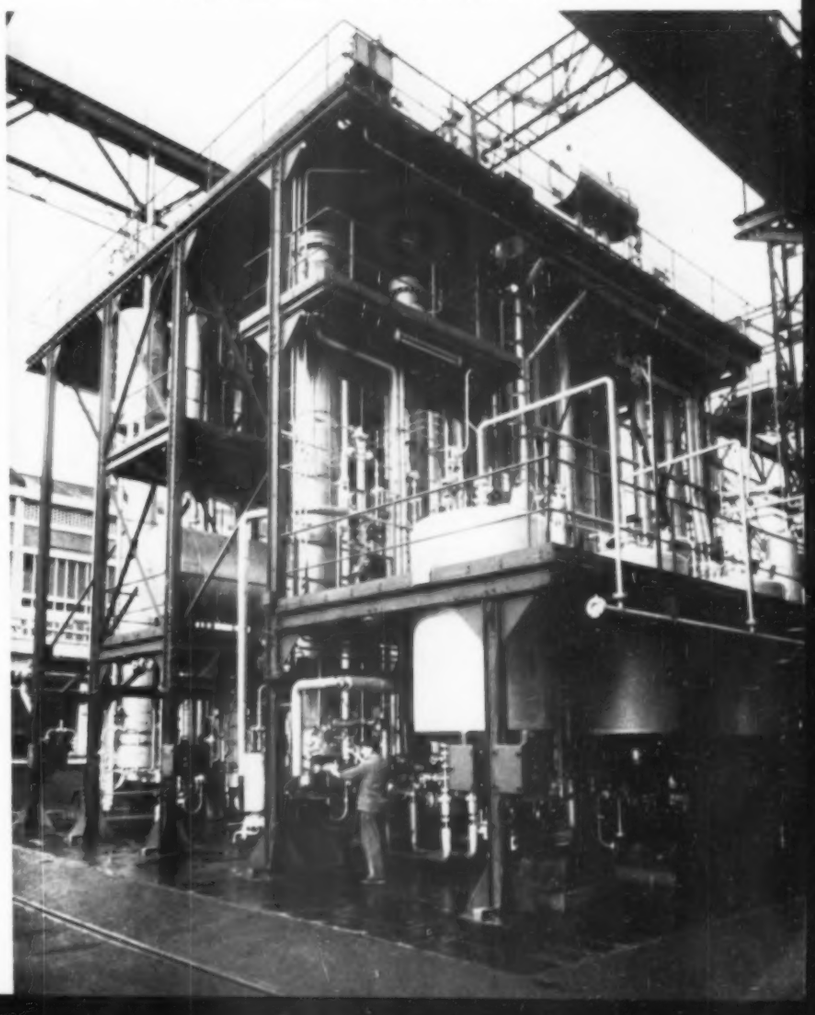
1. *Catalytic cracking units*

Companies	*Location*	*Capacity*
C.F.R. (Compagnie Française de Raffinage)	Gonfreville	19,000
	La Mède	11,000
Esso Standard S.A.F.	Port-Jérôme	10,000
	Port-Jérôme	10,000
Shell-Berre	Petit-Couronne	10,000
	Berre	10,000
Mobiloil Française	Frontignan	10,000
Antar	Donges	10,000
Caltex	Ambès	4,600
Total		94,600



Unit of synthesis of OXO alcohols at the HARNES (Pas de Calais) plant of Ste Contrières Kuhlmann.

Production of synthetic gas by cracking of fuel, Texaco process, at the Paimboeuf (Loire-Atlantique) plant of Ets Kuhlmann.



They are all operating at present. New projects are being studied. Due however to the effect of the composition of Sahara crudes on the processing procedures of French refineries, it may be expected that those projects will be revised in accordance with motor fuel requirements. It is therefore likely that, in the future, new olefin requirements will be met, preferably through using steam cracking type processes more specifically designed for the production of these products.

2. *Steam cracking units*

Two units of this type are operating at present in France: One is at Lavéra, belonging to the Naphtachimie Company. It has been in operating order since 1953, the present 3,000 b/d capacity of which is to be increased to 7,500 b/d by 1960.

The other steam cracker is located at Port Jérôme, belonging to Esso Standard S.A.F. It is now being started up. The capacity is 5,300 b/d.

Some projects, not yet sufficiently outlined, lead to the conclusion that new units of this type of cracking may be built within the coming years.

3. *Catalytic reforming units*

These reforming units originally intended for the production of high octane gasoline, rich in aromatic hydrocarbons, are now often used for petrochemistry's needs. As a matter of fact, they afford means of extracting benzene, toluene, ethyl-benzene, as well as orthoxylene and paraxylene, from the distillates processed. Their capacities, again expressed in terms of fresh feed tonnage are listed in the table above right together with the capacities of the future facilities contemplated.

II—Development of the French Chemical Industry

After having described the evolution of the French Oil Industry with respect to its resources, its refining activities and those of its facilities operated to produce the basic hydrocarbons which chemical synthesis requires, it may be worth while to put forward a few facts which give an idea of the particularly intensive extent of development of the French chemical industry in the course of the past few years as, from both a quality and quantity standpoint, it is more and more obliged, as we said before, to resort to petroleum to meet its increasing needs.

First, the French chemical industry's production indexes (the highest among all the branches of the French industrial activity) are given below, basis 100 in 1952:

Year	*Index*
1938	67
1952	*100*
1953	107
1954	124
1955	149
1956	163
1957	184
1958	210

It should also be pointed out, to be even more accurate, that the index of organic chemicals considered alone, which more directly concerns petrochemistry, reached 351 (last figure published) in September 1958, a figure which evidences the strong vitality of this industrial branch.

This expansion of the French chemical industry has moreover materialized in a very strong effort in the research field, the results of which have already reached appreciable levels: thus as early as in 1956, it has been observed that the balance of foreign exchange of patents and licenses was showing profits. At present, the French chemical companies are devoting, on an average, 2 to 3% (investments not included) of their cash flow to laboratory research. This sum calculated proportionally to the various parity rates of the French Franc with the US Dollar has progressed from US $2,543 million in 1955 to US $2,731 million in 1956 and to US $2,788 million in 1957, and it is estimated that it reached a fairly equal value in 1958, in spite of the fact that the turnover of related industries, such as the rubber, fats, synthetic fibers and glass industries, is not included in the figures just mentioned. As regards employment, it is rather steady and involves approximately 234,000 persons, out of which 21,000 are engineers and higher bracket employees, 48,000 clerks and 165,000 workers.

Catalytic Reforming Units

Companies	Location	Process	Start up date	Capacity (b/d)
Esso Standard S.A.F.	Port-Jérôme	Powerformer	1959	13,000
Esso Standard S.A.F.	Bordeaux	Powerformer	1959	4,800
Esso Standard S.A.F.	Bordeaux		1961	2,400
C.F.R. (Compagnie Française de Raffinage)	La Mede	Powerformer	1959	20,000
Mobiloil Francaise	N.D. de Gravenchon	Sovaformer	1957	3,300
	Frontignan	Sovaformer	1959	6,500
Antar P.A.	Donges	Houdriformer	1957	10,000
Societe Francaise des Petroles B.P.	Lavera	Platformer	1957	5,000
	Dunkerque	Platformer	1959	10,000
Shell	Petit-Couronne	Platformer	1959	2,000
	Berre	Platformer	1961	13,000
Caltex	?	Platformer	1962	3,000
		Total		103,000

FRENCH PETROCHEMICAL PLANTS

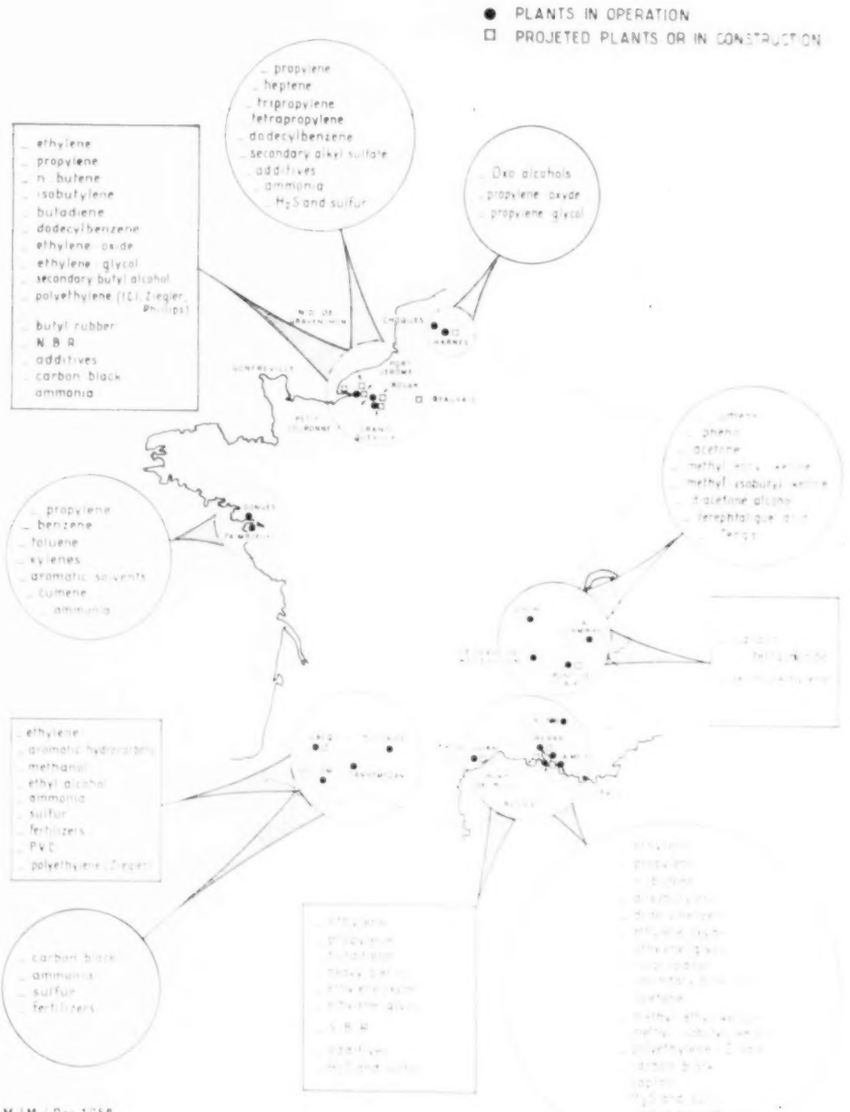


Table 1—Production of Olefins

(a) Existing plants

Product manufactured	Producing Company	Location	Start-up date
Ethylene	Naphtachimie	Lavéra	1953
Propylene	Naphtachimie	Lavéra	1953
"	Compagnie Française de Raffinage	La Mède	1953
"	Antar P.A.	Donges	1953
"	Shell-Berre	Berre	1953
"	Esso Standard S.A.F.	Port-Jérôme	1955
N-Butene	Shell-Berre	Berre	1958
Diisobutylene	Shell-Saint Gobain	Berre	1958
Heptene	Compagnie Française de Raffinage	Gonfreville	1958
Tripropylene	Esso Standard S.A.F.	Port-Jérôme	1955
"	Compagnie Française de Raffinage	Gonfreville	1958
Tetrapropylene	Esso Standard S.A.F.	Port-Jérôme	1955
"	Compagnie Française de Raffinage	Gonfreville	1958

[1] Estimated yearly production (end 1958) = 138,000 mt

(b) Plants projected

Product manufactured	Producing Company	Location	Start-up date
Ethylene	Esso Standard S.A.F.	Port-Jérôme	1959
"	Compagnie Française de Raffinage	Gonfreville	1959
"	Naphtachimie	Lavéra	1961
"	S.N.P.A.	Lacq	1962
Propylene	Esso Standard S.A.F.	Port-Jérôme	1959
"	Naphtachimie	Lavéra	1961
N-Butene	Esso Standard S.A.F.	Port-Jérôme	1959
Isobutylene	Esso Standard S.A.F.	Port-Jérôme	1959
"	Compagnie Française de Raffinage	Gonfreville	1959
"	Shell-Saint Gobain	Berre	1959
C_4-C_{10} cut	Shell-Saint Gobain	Berre	1959
C_{11}-C_{14} cut	Shell-Saint Gobain	Berre	1959

Estimated additional yearly production capacity in 1962 = 248,000 mt

Table 2—Production of Diolefins

(a) Existing plant

Product manufactured	Producing Company	Location	Start-up date
Butadiene	Naphtachimie	Lavéra	1957

The present capacity of this plant may be estimated at about 4,000 mt/yr. It should be noted however that this is not butadiene for polymerisation purposes, but only a butadiene stream from the steam cracking unit of Naphtachimie Company, part of which being only used to produce tetrahydrophthalimide necessary for Captan manufacture.

(b) Plants projected

Product manufactured	Producing Company	Location	Start-up date
Butadiene	Esso Standard S.A.F.	Port-Jérôme	1959
"	Naphtachimie	Lavéra	1961
"	Société des Elastomères de Synthèse[1]	Berre	1962

Estimated additional yearly production capacity in 1962 = 52,500 mt

[1] For manufacturing 50,000 mt of S.B.R.

Table 3—Production of Aromatic Hydrocarbons

(a) Existing plants

Product manufactured	Producing Company	Location	Start-up date
Benzene	Antar P.A.	Donges	1958
Toluene	Antar P.A.	Donges	1958
C_8 Ixylenes and ethylbenzene)	Antar P.A.	Donges	1958
Heavy aromatic solvents	Antar P.A.	Donges	1958

Estimated yearly production capacity (end 1958) = 41,700 mt

(b) Plants projected

Product manufactured	Producing Company	Location	Start-up date
Benzene	Antar P.A.	Donges	1962
Toluene	Antar P.A.	Donges	1962
C_8 Ixylenes and ethylbenzene[1])	Antar P.A.	Donges	1962
Heavy aromatic solvents	Antar P.A.	Donges	1962

Estimated additional yearly production capacity in 1962 = 56,500 mt

Antar P.A. considers extracting paraxylene and also ethylbenzene from the C_8 fraction. Other petroleum companies or natural gas producers also are looking into the question.

Table 4—Production of direct Olefins derivatives

(a) Existing plants

Product manufactured	Producing Company	Location	Start-up date
Ethylene oxide	Naphtachimie	Lavéra	1953
Propylene oxide	Marles-Kuhlmann	Chocques	1957
Isopropanol	Naphtachimie	Lavéra	1953
"	Shell-Saint Gobain	Berre	1953
Acetone (from cumene)	Progil-Electrochimie	Pont-de-Claix	1954
" "	Rhône-Poulenc	Peage-de-Roussillon	1954
Secondary Butyl alcohol	Shell-Saint Gobain	Berre	1956
Oxo alcohols	Courrieres-Kuhlmann	Harnes	1956
Dodecylbenzene	Standard-Kuhlmann	L'Estaque	1949
"	Petrosynthese	Gonfreville	1958
"	Shell-Saint Gobain	Berre	1958
Secondary Alkyl sulfate	Shell-Saint Gobain	Petit-Couronne	1951
Epikote resins	Shell-Saint Gobain	Berre	1957
Chlorinated solvents	Pechiney	Saint-Auban	1957
" " [1]	Progil	Pont-de-Claix	1958

Estimated yearly production capacity (end 1958) = 151,000 mt

[1] Perchloroethylene, carbon tetrachloride, allyl chloride, dichloropropane, etc.

(b) Plants projected

Product manufactured	Producing Company	Location	Start-up date
Ethylene oxide	Marles-Kuhlmann	Gonfreville	1959
"	Naphtachimie	Lavéra	1960
Propylene oxide	Naphtachimie	Lavéra	1959
Acetone (from cumene)	Rhône-Poulenc	Peage-de-Roussillon	1959
Secondary Butyl alcohol	Société Industrielle des Dérivés de l'Acétylène	Port-Jérôme	1960
Dodecylbenzene[1]	Esso Standard S.A.F.	Port-Jérôme	1959
LP Polyethylene	Manufacture Normande de Polyethylène	Gonfreville	1959
" "	Société Normande de Matieres Plastiques	Port-Jérôme	1959
" "	Naphtachimie	Lavéra	1959
HP Polyethylene	Ethylene Plastique Normandie	Port-Jérôme	1959
" "	—d°—	Lacq	1962
Vinyl chloride	Vinylacq	Lacq	1962
Polypropylene[2] (Montecatini process)	under consideration	not yet Exact up	end 1960
Epikote resins	Shell-Saint Gobain	Berre	1960

Estimated additional yearly production capacity in 1962 = 175,000 mt

[1] To supersede the present Estaque plant, with the same production capacity, that will be shut down as soon as the new plant is in operation.

[2] The Pechiney Company and Société Normande de Matieres Plastiques have entered into an agreement with Montecatini for the manufacture of polypropylene and a 10,000 mt/yr production of this polymer in a first stage is considered.

Table 5—Production of direct Diolefins derivatives

(a) Existing plant

This is the tetrahydrophthalimide manufacturing plant of Naphtachimie Company, started up in 1956 and located in Lavéra. The producing plant with an estimated production capacity of about 1,200 mt/yr, can meet the whole of the French market requirements. Tetrahydrophthalimide is especially used by California Spray Chemical for manufacturing Captan at its Port-de-Bouc plant.

(b) Plants projected

Product	Producing Company	Location	Start-up date
Butyl rubber[1]	Sacabu	Port-Jérôme	1959
Nitrile rubber and Kinetastic resins	Usine	Villers-Saint-Sépulcre	1960
S.B.R.	Société des Elastomères de Synthèse	Berre	1961

Estimated additional yearly production capacity in 1962 = 80,000 mt

[1] From isoprene imported from the United States.

Table 6—Production of direct Aromatic Hydrocarbons derivatives

(a) Existing plants

Product manufactured	Producing Company	Location	Start-up date
Phenol (from cumene)	Progil-Electrochimie	Pont-de-Claix	1954
" "	Rhône-Poulenc	Peage-de-Roussillon	1954

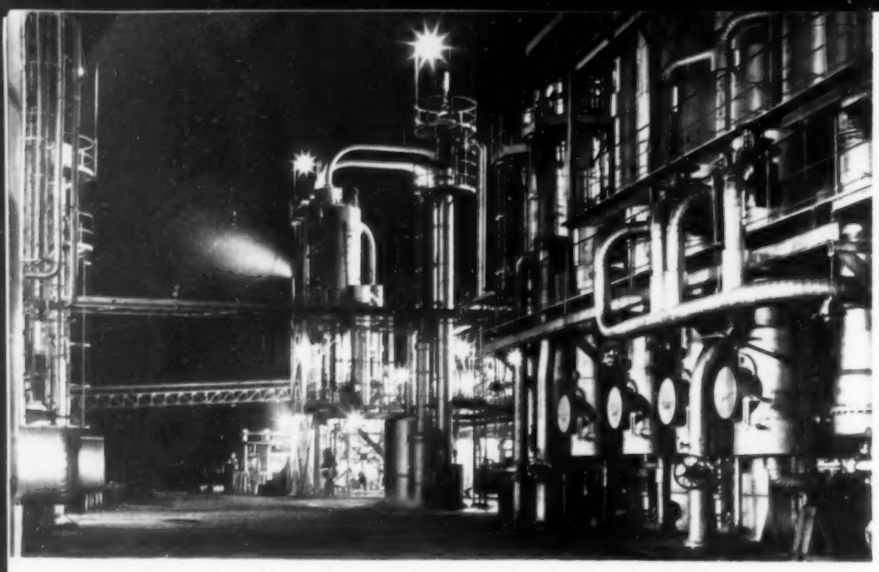
Estimated yearly production capacity (end 1958) = 36,000 mt

(b) Plants projected

Product	Producing Company [1]	Location	Start-up date
Phenol (from cumene)	Rhône-Poulenc	Peage-de-Roussillon	1959
Terephthalic Acid[2]	Rhodiacéta	Saint-Fons	1959

Estimated additional yearly production capacity in 1962 = 31,000 mt

[1] For manufacturing the synthetic fiber called "Terylene".



Naphtachimie—Lavera plant—manufacturing unit of ethylene-oxide derivatives.

If we now consider investments, we can see that they are steadily rising: they amounted to US $121 million in 1954, US $145 million in 1956 and US $154 million in 1955.

Those investments for a large part concerned organic chemistry and, more especially, petrochemistry which we shall now describe.

III—French Petrochemistry's Advance

Petrochemistry's advances in France may now be more easily accounted for after the excellent form, first of the petroleum industry and its petrochemical equipment facilities, second of the chemical industry, has been noted.

It should first be pointed out that investments in petrochemistry, expressed in terms of plants in operation, reached US $47.2 million late in 1955, US $50 million late in 1956, US $69 million late in 1957 and it is estimated that US $211 million will be devoted to the building of new facilities in the course of three years 1958, 1959 and 1960. If this occurs, investment figures will be four times as great at the end of 1960 as late in 1957.

As regards overall production of petrochemistry's activities as a whole, expressed in metric tons of carbon contents, from petroleum or natural gas, it rose from 50,000 mt in 1956 to 80,000 mt in 1957, an increase of 60% and it very probably reached 142,000 mt in 1958, an additional increase of 77% as compared with the previous year.

If we now look at the tonnage of petroleum products used in these various productions, the following progression may be noted:

	1954	*1955*	*1956*	*1957*
		(metric tons)		
Petroleum	31,000	78,000	91,000	77,000
Refinery gas	97,000	200,000	260,000	300,000
	128,000	278,000	351,000	377,000

It will be noticed that the tonnage increase of raw materials used is much less striking than that of petrochemicals produced. This is accounted for by the fact that refineries heading towards petrochemistry, are using more and more selective and efficient facilities as they become available, which enable them to draw their chemicals from smaller and smaller quantities of crude oil or natural gas.

It must also be noted that the figures mentioned above do not take into account the use of natural gas and of some petroleum cuts in the production of ammonia, sulfur and carbon black, which has for some years now in France, become of considerable importance.

The accompanying map shows the location of the main French petrochemical plants (either already existing or under consideration) together with the list of the main products processed by those plants, and it will be noticed that these facilities are located in six areas the most important of which are those of the Lower Seine, Lyon and Etang de Berre.

The variety of products either already currently manufactured or to be in the near future ranges widely from the simplest hydrocarbons such as olefins and diolefins with low carbon condensation, to more elaborate products such as ethylene oxide, cumene, dodecylbenzene and even to such finished products as acetone, phenol, secondary butanol methylethylketone, the oxo alcohols, secondary alkyl sulfates, butyl rubber, the various kinds of polyethylene, some lubricant additives, ammonia, carbon black, sulfur, etc. . . .

Table 7—Production of Carbon black

(a) Existing plant

Origin	Producing Company	Location	Start-up date
Heavy aromatic hydrocarbons (Shell-Saint Gobain)	Cabot France	Berre	1957

Estimated yearly production capacity (end 1958) = 20,000 mt.

(b) Plants projected

The first point to be noted in the expansion of the Cabot-France plant, this Company proposing to raise its manufacturing potential up to 45,000 mt/yr. from 1959 on. Furthermore, another company that already produces carbon black from heavy coal tar distillates is considering the possibility of increasing its production and using petroleum fractions. Another manufacturing plant project of Compagnie Française de Carbon Black is also announced but no particulars are given at present.

Table 8—Ammonia production

(a) Existing plants

Origin	Producing Company	Location	Start-up date
Natural gas	Office National Industriel de l'Azote (O.N.I.A.)	Toulouse	1951
Natural gas	Pierrefitte	Pierrefitte	1951
Natural gas	Société des Produits Azotés	Lannemezan	1951
Refinery gas	Société Chimique de la Grande Paroisse	Grand-Quevilly	1951
Refinery gas	Potasse et Engrais Chimiques	Petit-Quevilly	1957
Fuel Oil[1]	Kuhlmann	Paimboeuf	1957

Estimated yearly production capacity (end 1958) = 297,000 mt.

[1] Texaco process.

(b) Plants projected

Origin	Producing Company	Location	Start-up date
Natural gas	O.N.I.A.	Toulouse	1959/1960
Natural gas	Pierrefitte	Pierrefitte	1959/1960
Refinery gas	Société Chimique de la Grande Paroisse	Grand-Quevilly	1959/1960
Fuel Oil	Kuhlmann	Paimboeuf	1959/1960

Estimated additional yearly production capacity (end 1960) = 92,000 mt.

Table 9—Production of Sulfur

(a) Existing plants

Origin	Producing Company	Location	Start-up date
Refinery gas (Shell-Berre)	Saint-Gobain	Port-de-Bouc	1954
Refinery gas (Mobiloil Fse)	Saint-Gobain	Balaruc	1955
Refinery gas (Esso Standard, S.A.F.)	Nobel-Bozel	Port-Jérôme	1957
Natural gas from Lacq (S.N.P.A.)[1]	S.N.P.A.	Lacq	1957

Estimated yearly production capacity (end 1958) = 283,000 mt.

[1] It should be remembered that the natural gas from Lacq has an H_2S content above 15%.

(b) Plants projected

Origin	Producing Company	Location	When to reach full capacity
Natural gas from Lacq (S.N.P.A.)	S.N.P.A.	Lacq	1962

Estimated additional yearly production capacity (end 1962) = 1,000,000 mt.

In order to have an overall view of the French effort made in the field of petrochemistry, it is of some interest to examine, for each kind of chemicals produced, the evolution of production over the past years as well as the prospects for the future. The main data we have been able to secure in this connection are tabulated.

On examining the figures of French petrochemical production capacities (Tables 1 through 6), it is manifestly apparent that a great deal has been accomplished in the organic chemistry field since these figures show:

1. That by the end of 1958 production capacity of the main petrochemical hydrocarbons (olefins, diolefins and aromatic hydrocarbons) amounted to 185,200 mt and that of their chemical derivatives to 188,200 mt.

2. That by 1962, the production capacity of hydrocarbons will be further raised by 357,000 mt, and that of their derivatives by 272,000 mt so that the total hydrocarbons base production capacity at the time will be raised up to 542,000 mt and that of their chemical derivatives up to 460,200 mt.

In addition to these production capacities, those of carbon black, ammonia and sulfur have been mentioned in tables 7, 8 and 9. The figures therein reveal very large production capacities indeed that amounted to 600,000 mt by the end of 1958. They will be increased by 1,117,000 mt by 1962 whereby the total production capacity of these products will be raised to 1,717,000 mt.

Another particularly important field of petrochemical activity which, if it does not represent a considerable tonnage, is of the highest interest from a quality standpoint, is that of lubricant additives. These products are ever more necessary indeed given the variety of lubrication problems that are raised at an ever increasing rate nowadays. Here again, the activity of the French industry asserts itself by setting up new facilities that either cover new manufactures or increase already existing production capacities.

In order to gain a still fuller view of the possibilities of the French petrochemical industry, the vast potentialities of the Lacq natural gas field should not be overlooked; as mentioned above, this field gives rise to an ever expanding sulfur extraction industry which prompted the main French petrochemical companies to investigate a number of projects using methane as raw material for producing various chemicals. Thus, in what may be termed the integrated Lacq chemical industrial area, several Companies have been formed in order to make maximum use of the possibilities afforded by natural gas. In addition to ethylene, ammonia and sulfur manufacture already mentioned above, a series of other industries will appear most probably, such as acetylene, acetaldehyde, and butanol, methanol, various ammonia base fertilizers, vinyl chloride, etc. If these projects materialize in line with the production capacities anticipated at present, the Lacq integrated chemical industry will be no doubt a very large one indeed, since present projects cover in particular minimum production of 25,000 mt yr. of acetylene, 35,000 mt yr. of methanol and 180,000 mt of nitrogen base fertilizers, to which lesser tonnage production should be added such as methyl-mercaptan, ethyl-mercaptan and high purity hydrogen sulfide that will open the way for numerous synthyses of organic sulfurous products.

We cannot terminate this brief survey of French petrochemical manufactures without mentioning the possibilities that will open up in Algeria in the years to come due to huge reserves of crude oil and natural gas in the Sahara Departments. Several companies have already been formed in order to investigate all the possibilities for manufacturing petrochemicals in Algeria.

A comprehensive view of the French petrochemical industry indicates that it has been most flourishing and shows numerous possibilities of future growth. The reasons therefore have been given earlier in this report, but it appears useful to summarize the main ones:

1—Constant, intense and particularly well oriented growth of the French petroleum industry, in particular capable of furnishing the chemical industry with a most varied range of hydrocarbons.

2—Discoveries of considerable natural gas and oil fields for which we are indebted to a highly qualified staff and to thoroughly developed and particularly efficient organizations for exploration.

3—Constantly increasing requirements of basic raw materials for an extremely aggressive French chemical industry.

4—Finally, an increased activity of French research laboratories, with ever improving equipment, in a country whose bent to agriculture is now reinforced by a steadfast intent to succeed in the industrial field.

berliet

T100

from France
the world's
largest
truck
now
exhibited
at
Tulsa's
International
Petroleum
Exposition

Why the French built the world's largest truck the T 100

by Paul Berliet
Managing Director of Automobiles M. Berliet

WHEN we French decided to build the biggest truck in the world, it wasn't a question of showing off. We didn't build our Berliet T.100 just for glory. If the T.100, now Attraction Number One at the Tulsa Petroleum Exposition, is the world's biggest, it is because size becomes a geographical imperative.

In this case, the geographical imperative was imposed by the Sahara desert. Only within the last few years has France taken full account of the enormous wealth that lies beneath these desolate, windswept stretches. Oil, the lifeblood of modern times, which France was obliged to import, was discovered within the French community.

The oil was there—but reaching the oil was another story, particularly in the two great regions of ever moving dunes known as the Great Eastern Erg and the Great Western Erg.

The problem was to bring in the mud pumps, the winches and other equipment which drilling operations require across the African dunes. No existing transport combined the various qualities to do the job. We needed a truck which could successfully cross soft, windswept sand, which could climb up and down the steep slopes of the Sahara dunes—carrying a 30-ton-and-over load. The Golconda treasures of the Sahara could not be tapped until the oil men had solved their transport problems. I think there is an English proverb which states that "necessity is the mother of invention," and we French are very proud of our inventive spirit. We at Berliet, are the leading truck manufacturer in France, the second in Europe and the sixth largest producer in the world—we were determined to present the French petroleum industry with the working equipment it needed.

The T.100 is our desert giant. It was designed to meet a specific technical challenge and this challenge it has met and won. Each of its elements, each of its characteristics was planned and developed to accomplish the work in hand.

You may be interested in some of the facts and figures. The T.100's six tires are 37.5 by 33" with a diameter of 7'10", and a width of 38". The total rolling surface is 100 square feet. Art imitates nature, as they say, since the tire-to-ground pressure of this enormous 100-ton truck is only 14 psi, the exact weight of a camel's foot on the sand of the desert.

The T.100 No. 3 is presently having its desert workout. It is clearly evident that 30-ton loads can easily be carried over every type of ground and across very rugged country and enormous weights can be carried without injury to the road surface. We feel our T.100 is almost human and it grins triumphantly at the obstacle of muddy quarries, rocky untracked country or snow and ice.

The engine and all the component parts of the T.100 have been redesigned to match the enormous new scale imposed by its tires, by the loading surface and by the invincible ruggedness which we felt should characterize it—and by its engine power.

This engine is a Cummins Diesel V 12 with 600 hp SAE. A hydraulic coupler connects with a gearbox of eight forward and eight reverse speeds which make it possible for the T.100 to surmount any obstacle. Let me give you an example. On a dry meadow, the T.100, with a load, can start off in fifth gear. Three de-multipliers connect the gear box and the three engine axles—the third, a planetary type is located in the hub of each wheel. The differentials which divide the power between the axles and between the wheels are self-locking, but with a margin of security. For this reason, each wheel can always make use of maximum power compatible with its ground grip.

The dimensions of the loading surface are 20'9½" by 15'8". The heaviest materials can be loaded without difficulty. It could fit a 2-room apartment quite comfortably. A 50-ton winch facilitates loading operations.

The T.100 is as easy to drive as your own private car—all controls are power assisted, of course. The steering wheel is easy to turn; there is a speed selector, a foot brake, a foot accelerator—and that is all.

The comfort of the driver and his crew in their desert cruiser has been a particular consideration of ours—we've spent some time in the Sahara ourselves. The driver's cab is entirely air conditioned and soundproofed. There are five seats placed side by side and several bunks. The low tire pressure absorbs most of the irregularity of the terrain. However, to improve suspension to the maximum, the forward axle includes two sets of special, extra large hydraulic shock absorbers.

The driver can consult a wheel indicator which informs him of the angle of the front wheels; also a compass for uncharted territories and a radio which can send and receive messages.

Cabin equipment also includes tanks of fresh drinking water, a stove and other conveniences which make long distance travel possible without fatigue.

All the various assemblies of the T.100 are sand-tight and dust-tight, two obvious prerequisites for successful operation in desert regions.

These are the outstanding characteristics of our new and revolutionary truck. Thanks to our desert giant, new roads open before the world's major oil producers. The costly construction of paved roads is no longer the necessary prelude to exploring and working on virgin territories.

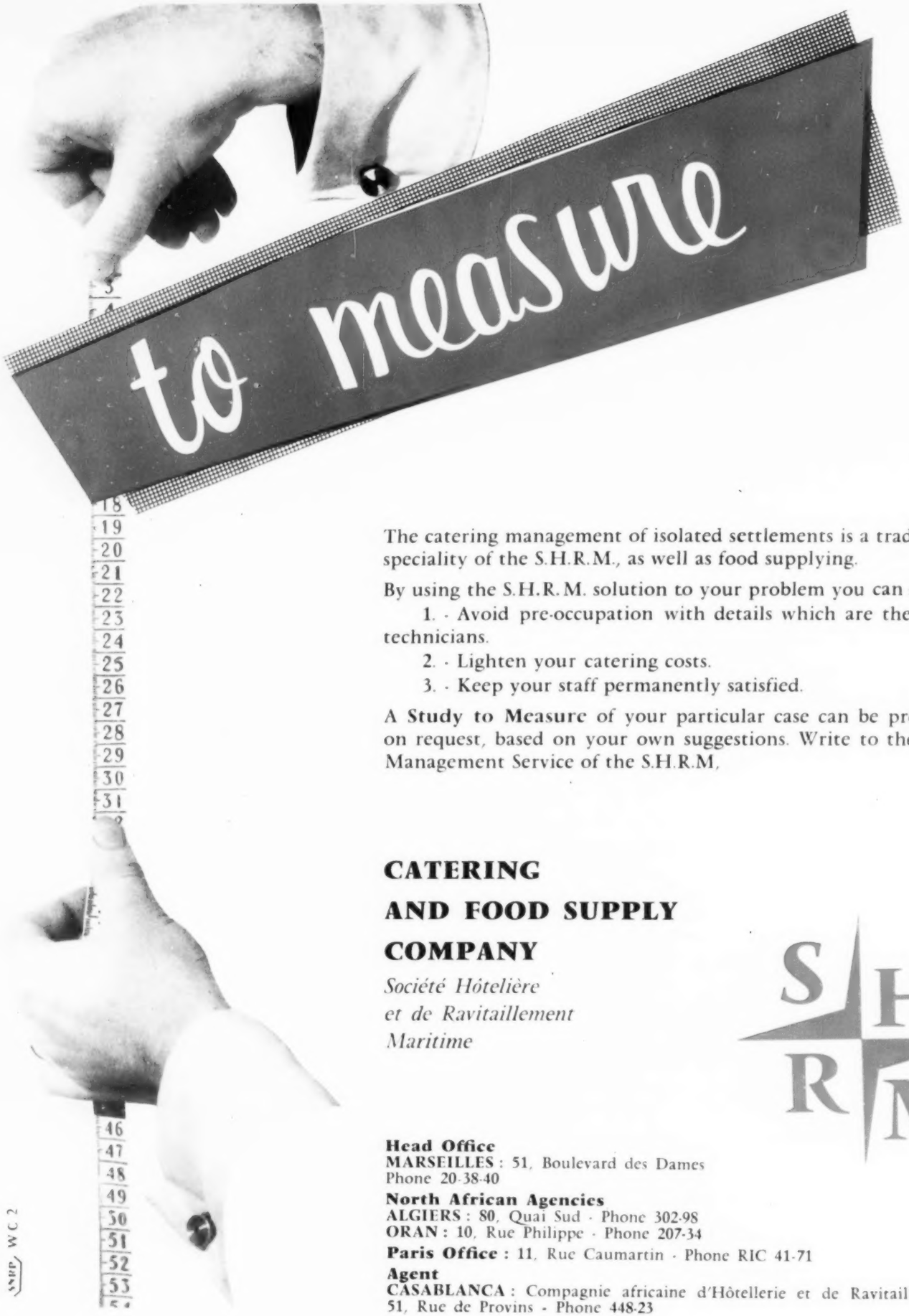
In addition to its unusual transport and climbing facilities the T.100 can also be used as an upkeep unit or as a fixed power unit. Its ease of handling makes it most helpful in construction work.

May I confess that I, as a French manufacturer, am very proud to bring to America, the cradle of the oil industry so to speak, this French contribution to the world of tomorrow.

During the course of its trip to America, the Berliet T.100 will be shown at the International Petroleum Exposition at Tulsa. After the Tulsa show, the T.100 will be presented at the Fifth World Petroleum Congress to be held in New York from May 30 to June 5, 1959.

The Chicago International Trade Fair to be held in early July, has asked Berliet and its truck to be its guest of honor for 1959—an invitation which has been warmly accepted.

The T.100 which is now in the United States is the fourth unit to bear the name. The three previous units have also spent much of their time traveling. One is undergoing test runs in French quarries. Another was shown at the Fair of Helsingfors in Finland. And the third is working with the oil experts in the Sahara petroleum fields.



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By using the S.H.R.M. solution to your problem you can :

1. - Avoid pre-occupation with details which are the job of technicians.
2. - Lighten your catering costs.
3. - Keep your staff permanently satisfied.

A **Study to Measure** of your particular case can be presented on request, based on your own suggestions. Write to the Camp Management Service of the S.H.R.M,

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in charge of commercial affairs.

THE trade-mark and the initials S.H.R.M. which symbolize a true tradition of competence, do not only indicate the initial activity of the SOCIETE HOTELIERE ET DE RAVITAILLEMENT MARITIME. As a matter of fact, since its establishment, a little more than 50 years ago, the S.H.R.M. has always been anxious to fill each new need as it arises. Therefore, as the time passed, the S.H.R.M. has considerably increased its activities which could, in 1959, be summarised as follows:

I—Original function

1. *On the sea*

The traditional activity of the S.H.R.M. was the supplying and provisioning of ships of different Companies, in particular the COMPAGNIE DES TRANSPORTS OCEANIQUES, COMPAGNIE DES MESSAGERIES MARITIMES and the COMPAGNIE GENERALE TRANSATLANTIQUE (Mediterranean fleet). For example, the S.H.R.M. provides the hotel and restaurant services on board for shipping companies. Its commercial relations are on a world scale, and it can be said that the chain of its suppliers, of all kinds and all nationalities, reaches all shipping lines. The maritime activities of the S.H.R.M. cover at present a hundred or more ships.

2. *In the air*

With the rapid development of air travel, the problem of catering on board aircraft, a direct competitor of shipping, could not fail to interest the S.H.R.M. And so the Company arranges at the Airport of Marseilles Marignane meals for travellers awaiting departure and for people in transit, as well as meals on board the aircraft of the various Air Lines whose planes use this Airport.

3. *On land*

On land, the S.H.R.M. in its desire to encourage the growth of tourism, has built and runs at "Ile Rousse," the "golden beach" of Corsica, a resort where tourists of various nationalities may meet.

II—New activities

In the Sahara desert

From ALGIERS, where it has an Agency, the S.H.R.M. is taking part in the great Sahara adventure. In its own field of catering and hotel management, during the "heroic" period of 1951, it started to help those pioneers who have undertaken the job exploiting the resources of the Sahara. Adapting itself to the needs created by the development of research and the implantation of industries—especially those connected with oil—the S.H.R.M. has put into operation new kinds of catering and hotel projects. The Company is now able to meet with every need whatsoever:

—In particular, the S.H.R.M. undertakes the provisioning of petroleum centers, wherever they may be found. A telephone call from the client's headquarters, or a written request from the Saharan Center, brings immediately the requested quantities of drinks, food or any other supplies, packaged and transported in conditions appropriate to desert and other climatic considerations. The "cold link" runs from ALGIERS straight to the consumer.

Even better, anxious to bring the best possible service to Petroleum Companies and their contractors, the specialized department of the S.H.R.M. can arrange for supplies, as well as menus, to be sent to their clients for an agreed period; only the number of people to be served has to be indicated:

—Alternatively, the S.H.R.M. can take over the management of Saharan camps, making special contracting arrangements for each particular case. By using this complete service, clients find themselves entirely free from the catering problems which the foundation of a new center poses, and which are the business of specialists.

In addition, the S.H.R.M. thanks to its OUED-IRARA Hotel at HASSI-MESSAOUD, can receive in its own quarters visiting officials or clients of the existing firms.

Due to its important hotel installations, to its large staff of trained personnel, to its variety of products and supplies on hand which can be furnished immediately, and because services have been designed especially to meet the requirements of the Sahara area, the S.H.R.M. is fully prepared to service all requests to the satisfaction of its clients.

The increasing number of its references and their quality are the best proof of the efficiency of the S.H.R.M. "Complete service."

A list of references and a descriptive leaflet of the various services applicable to various cases will be furnished on request.

Bureau de Recherches du Petrole

(Continued from page 9)

As far as gas is concerned, the use of the enormous quantities discovered at Hassi R'Mel involves many problems and great difficulties. From the point of view of profitability alone, the present needs of Algeria and even of the whole Maghreb would not justify the laying of feeders. On the other hand, some solution must be found within the framework of the industrial development provided for by the Constantine plane, and taking account of the studies which are being made by SEGANS and Gaz de France, respectively, with a view to moving this gas to Europe. Three methods are under consideration: crossing the Mediterranean at great depth from Mostaganem to Cartagena, crossing the Straits of Gibraltar, or transferring liquid methane.

These large reserves of energy are less expensive than the old continent's own sources of supply, and being situated in immediate proximity to it may contribute substantially to its revival.

In the present situation the future of Europe cannot be separated from that of Africa.

Another fact to be considered is that the existence of oil on the African continent will divert the interest which has so far been exclusively directed towards other areas of production, and should therefore contribute to relieving a tension which is a threat and a cause of anxiety for the peace of the world.

But this means that Africans and Europeans must shoulder all their responsibilities which are so closely interdependent.

The Africans must allow and facilitate the development of their wealth of hydrocarbon resources.

On their part, the Europeans must organize the working of the oil fields by providing stable markets and extend their benefits to the African populations concerned, without evading the normal consequences of this exploitation. In particular, they must agree to an entirely local taxation at an adequate rate, participate in promoting the status of local workers and their standard of living, and gradually extend the establishment in Africa of such industries which can be profitably carried on there.

The work which has been progressively done for the last 15 years for developing the Saharian hydrocarbon deposits is of great magnitude and importance, not only by its geographical extent, its technical difficulties, its first results, but by those which can be reasonably expected.

It is important also from the point of view of its economic and social consequences.

It has required, and still requires, considerable efforts on the part of the men who are accomplishing it, far from their homes and families and in many cases under very rough conditions of life.

It is a fundamental element in the construction of a united Europe and in the improvement of the life of Africa.

Efficiency through cooporation

Development of CMS Blanose in drilling muds

Ou. technicians and drillers in general know the importance of mud and its paramount influence on the drilling results.

The first muds to be used were colloidal suspensions of clay in water. These muds were sensitive to electrolyes and were flocculated when circulating through salt beds. They were not adapted to the conditions of deep drilling and presented poor resistance to high temperatures and pressures. It was necessary to search for chemical products able to protect muds and give them unvarying characteristics whatever the drilling conditions might be.

Frequently, introduction and adaptation of treating agents have only been possible, through close cooperation between drillers and producers, it was precisely what happend with CMC Blanose.

During 1947, in France, as well as in different other countries, drillers who had been using for a few years, starch as protective colloid in muds, investigated on cellulose derivatives. They tried sodium CMC and more specially CMC Blanose which was just appearing on the market.

With the intent to work out products perfectly adapted to drilling conditions, the technicians of the producing firm immediately offered their help to oil companies and studied special types. The first field and laboratory trials were performed at Regie Autonome des Petroles. Mr. Thomas, then mud superintendent, acknowledged at once the very advantages of sodium CMC for drilling muds. Moreover, he published an essay about these organic colloids for which he obtained a reward "prix Charles Bihorcau."

The producer asked to work in collaboration with "l'Institut Francais du Petrole" which agreed to test in its laboratories the very numerous submitted grades.

The encouraging results which concluded the first trials were confirmed very soon by other important oil companies such as Societe Nationale des Petroles Languerdoc Mediterranee and Societe Nationale des Petroles d'Aquitaine.

CMC Blanose used at that time was available in the form of flakes easily soluble in water containing 30% active matter. It was a low viscosity grade: various tests performed, at l'Institute Francais du Petrole having shown in fact that a low viscosity grade was more suitable for bentonitic muds.

Already results obtained were good. It is reported for instance that for a 10,000 foot well drilled through chalky formations, it has been possible by adding Blanose to a bentonitic mud treated with tanin to keep proper characteristics and to maintain the A.P.I. waterloss below 8 cc.

For an ordinary bentonic mud, treated by 10 gr. 1. pure sodium CMC, the following performances were:
A.P.I. water loss: between 6cc and 10cc
Resistance to contaminants: total resistance up to 12 15 gr. 1. ClNa

Blanose found rapidly a great favor and drillers attempted to extend its use to all types of drilling muds; but it was then necessary to improve its resistance to physical and chemical factors, and specially to contaminants.

Various laboratory tests performed in 1948 showed that a product with higher substitution degree owing to better colloïdal properties was more resistant to electrolytes and could be used in almost any type of aqueous mud.

A new grade of high substitution degree —1—was developed and proposed on the market at the beginning of 1949. This Blanose which contained about 30% active matter and 40% water tended to coagulate in storage making difficult its solution in water.

At Novacel, successful trials were performed and a powder grade at about 50% active matter and 5% water was introduced: Blanose BS 510. During 1951-1952 the wet product was progressively replaced by Blanose BS 510, which offered to drillers many advantages, such as savings on transportation costs and no risks of coagulation.

This development has not been realized easily.

In order to keep all colloidal properties of CMC, the drying process had to be carefully controlled. The collaboration of drillers was again very helpful to Novacel technicians who, in full accordance with their observations and even suggestions could work out a very successful technique:

Since 1954, the development of Blanose BS 510 has undergone a tremendous increase, this grade which can be used in practically any type of aqueous mud has become the most widely employed. It gives real security at minimum cost.

Lastly the range of Blanose for drilling muds has been extended. Several oil companies and among them the one which had to overcome difficult problems at Lacq have asked for pure grades.

The purified CMC furnished by Novacel proved to have been very efficient for several reasons: transportation costs were lowered at minimum, mud resistivity could be maintained at the required level since the products were practically free of any mineral salt: high viscosity CMC could be furnished to prepare low solid muds, and heavy weighted muds. In the United States drillers started with purified grades and a few years later adopted technical grades. Driscose for instance is available in both types, in France it has been the reverse order.

As a conclusion, let us point out that Novacel has perfected a wide range of CMC adapted to drilling conditions.

A technical, inexpensive and easy grade to use: *Blanose BS 510:* sodium CMC, of a low viscosity and a high substitution degree.

Purified grades: *Blanose R 510:* sodium CMC, purified, neutral, dry, of a low viscosity and a high substitution degree. *Blanose R 190:* sodium CMC, purified, neutral, dry, of a high viscosity.

These special CMC, have been developed through the very close cooperation of French Oil Companies, l'Institut Francais du Petrole, with Novacel.

No doubt this still continuing cooperation will make easier the introduction of new drilling techniques.

Advertisement

Diamond coring—drilling in the oilfield.

It is no longer true that diamond coring in an oil well is a mysterious and difficult operation, requiring continuous expert supervision. Diamond coring is very much like other methods of coring; but for best results diamond coring should be conducted more technically than other methods.

Local service. Diamond coring, as now applied in the oil field, was pioneered by Drilling & Service Inc., of Dallas, Texas, and this company has expanded internationally to provide closer cooperation with operators in other countries. "Drilling & Service" designed core bits for all types of core barrels and drilling bits are manufactured in France by—Precidia S.A., 7 & 9 Impasse Milord, Paris 18e, Telephone: MARcadel 92-60, who have "Drilling & Service" trained engineers available for drilling sites in Europe, North Africa; and the Middle East.

Similar organizations, subsidiaries of Drilling & Service Inc., Dallas, are operating in England and Italy, also providing the services of "Drilling & Service" trained engineers, and manufacturing facilities through L. M. Van Moppes & Sons (Diamond Tools) Ltd, and their associated companies. All "D & S" bits are made under license from the Wheel Trueing Tool Co. of Detroit, U.S.A. and bear the trale mark TRUCO.

Bit design. With the world wide experience gained through Drilling & Service Inc., operations, and with European based field engineers, diamond set bits are now custom designed to suit individual conditions. It will be readily appreciated that this can be a major factor in increasing coring and drilling rates and reducing cost per meter.

It has also been found that large increases in diamond coring and drilling rates have been made possible as a result of extensive research in the field of diamond drilling and coring hydraulics. Knowledge derived from this work has led to the development of "Jet Coring Technology" or the effective application of rotary speed and increased bit weight made possible by the correct utilization of high velocity jet streams at the bit face for efficient removal of cuttings. This high velocity has been made possible by virtue of the development by Drilling & Service Inc., of a more erosion resistant matrix holding the diamond cutting elements.

Experience shows that the penetration rate and diamond life is directly related to the fluid horsepower delivered to the bit. Fluid horsepower is a function of pressure drop and the volume of fluid circulated. The pressure drop is a function of fluid velocity across the bit face and the physical properties of the drilling mud. The "Drilling & Service" bit, designed with these factors in mind, as well as the formation, operates with the maximum available fluid volume that can be delivered to the drilling depth. Therefore maximum "jet action" at the bit face results in:

1. faster rate of penetration.
2. maximum fooling of each diamond point, ensuring longer bit life.
3. the same annular velocity as with a rock bit, keeping the hole in good condition.

A further interesting feature of "Drilling & Service" core bits and drilling bits is the change in shape from the full circle to three flat surfaces reducing the contact area of the outer diameter of the bit and the hole wall.

This design is known as "TRI-DIA" and the reduced wall contact, designed for safety, gives the following advantages:

1. Minimizes junk iron hazard by allowing clearance for large pieces.
2. Facilitates washing out of cavings in the hole.
3. Reduces sticking due to mud wall cake.
4. Eliminates swabbing or hydraulic action when pulling out and running in the hole.

The success of diamond coring depends upon:

1. Selecting the correct bit designed to suit (1) mud volume circulated (2) type of mud (3) formation. Each "D & S Jet Action" bit is custom designed to suit the conditions, thus assuring peak performance. Bits to fit most makes of core barrel can be manufactured in France, England or Italy.

2. Selecting the best core barrel to suit (1) available hydraulic equipment (2) hole conditions (3) formation. Drilling & Service Inc., of Dallas, Texas, U.S.A. offer a series of 17 different core barrels to meet all requirements of the oilfield. These barrels feature simplicity of design and are all thoroughly field tested and proved.

3. Using the correct drilling technique. "Drilling & Service" trained field engineers are operating in Europe, North Africa, and the Middle East to make recommendations and to instruct drilling crews.

Drilling & Service Inc., can claim to have contributed largely to the establishment of diamond coring and drilling in the oil field as the very useful tool it has become. It's equipment and bits were designed to match existing oilfield equipment and methods of operation can easily be applied by any competent drilling crew. Design has since been modified and is constantly under review to effect economies and improve efficiency. Diamond coring and drilling is continually developing, and air coring, the "jet action" and "TRI-DIA" designs are improving results obtained in oilfields in France and in many other parts of the world.

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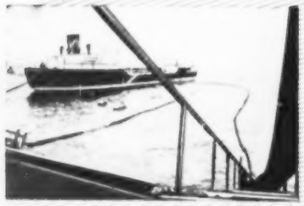

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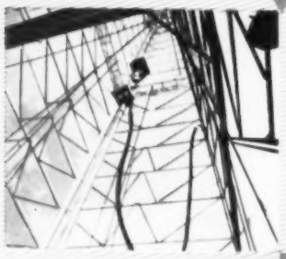

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The Institute Francais du Petrole

(Continued from page 42)

to enthusiastic young technicians and experienced engineers who are equally anxious, by perfecting their knowledge and capacity, to solve a problem of vital importance for our country, that we owe the sudden development of our corps of technicians and the efficiency they have shown in the industrial achievement which France can show the world to-day.

Saint Marcet, Lacq, all the known fields in the Sahara, all the discoveries in Gabon, all those which are being repeated in the Paris basin, are the achievement of French technicians exclusively. Starting from scratch, they have been able to predict these achievements, they have been able to carry them out, often in the teeth of all recognized forecasts to the contrary, with such resources as our country has been able to make available and at a cost which places our young discoveries in a particularly advantageous operational position from the economic point of view.

In proclaiming this today we are not forgetting all our French technicians owe in this connection to their predecessors. With unfailing generosity all the companies in all countries and all the institutions have given us the benefit of their knowledge and experience. It is a tribute to their great merit to emphasize how we have been able to turn this knowledge and experience to account in connection with the discovery of oil fields and what we shall soon show we are able to do with them after having reconstituted and developed our refining industry along modern lines and with new processes.

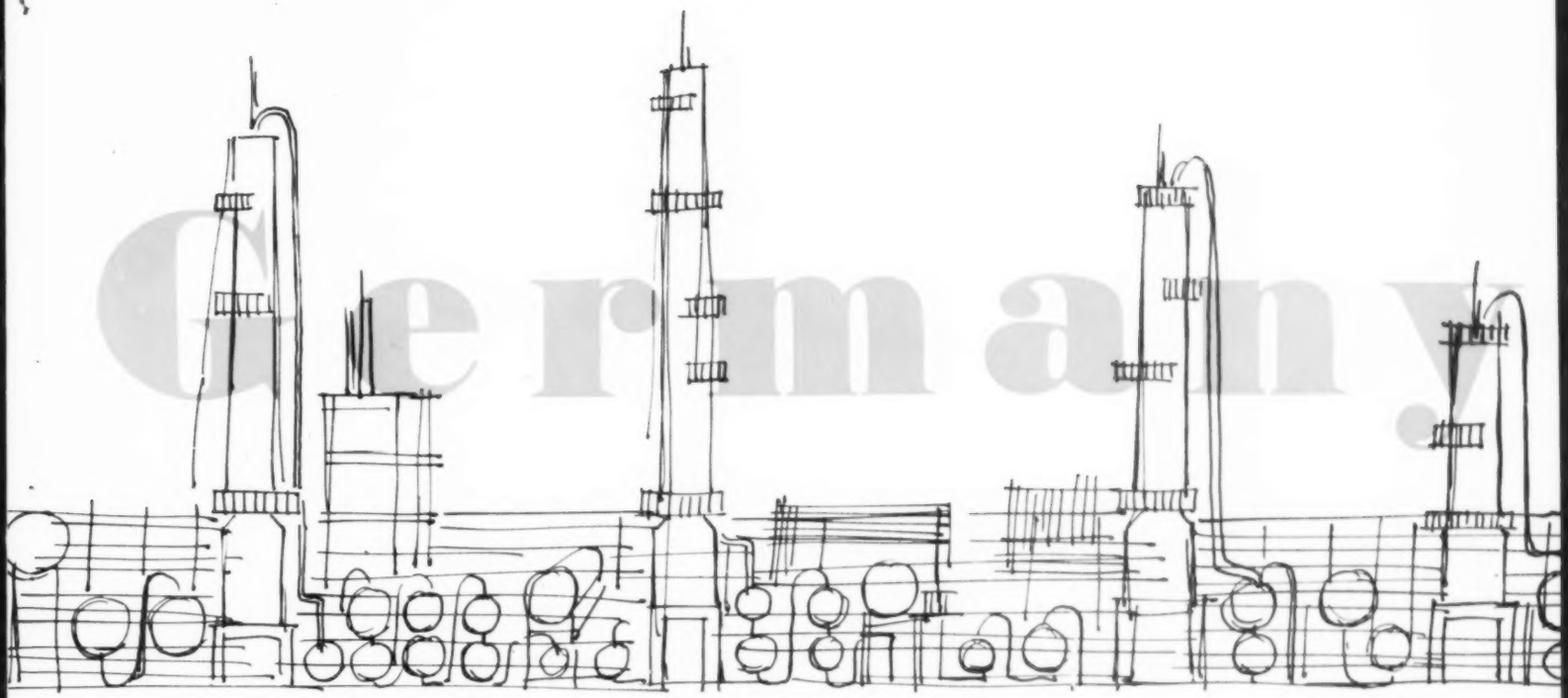
To describe what we have done and what we shall be doing is also to tell those peoples whose petroleum industry is still in the early stages of development that we feel obligated, by the very benefits we ourselves have enjoyed, to make our knowledge available to them in our turn, on the level to which we have raised it.

To all those who are faced with problems hitherto unknown to them, such as those which France had to solve in 1945, we say:

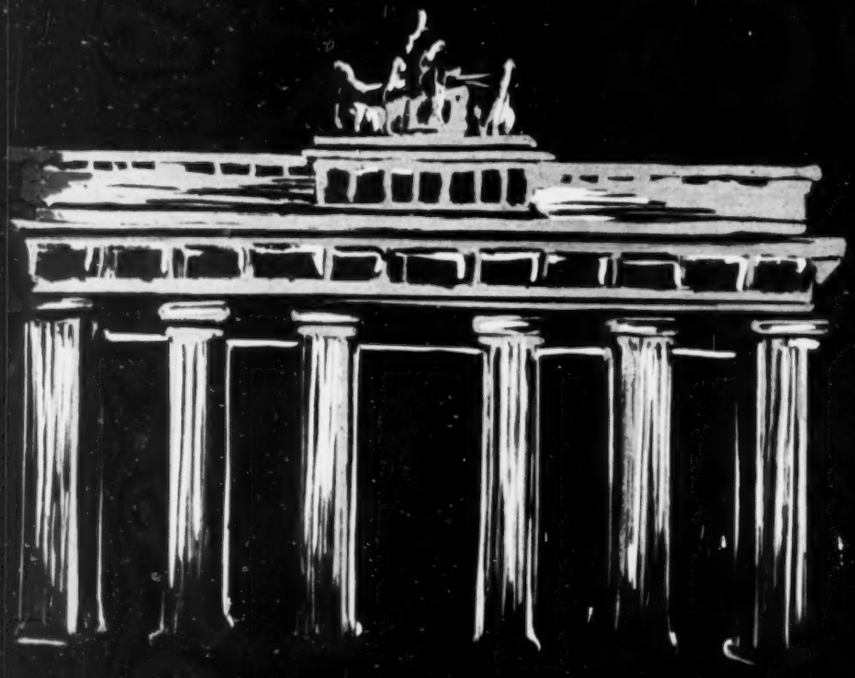
"Our experience is applicable to your problems owing to the very nature of the latter, and also owing to the physical conditions and circumstances as to personnel under which you have to solve them. Our training schools, our laboratories are open to you, our services are at your disposal. We are ready and anxious to adapt our experience and our methods to your country.

"To all those who have preceded us we first of all express our gratitude for everything they have passed on to us, and we add that we should feel highly honored if we could one day repay them by contributing efficaciously in our turn to their work."

An American professor who came to Paris to give courses at our institute told me that the greatest reward any teacher could have is to be able one day to learn something from his pupil. I believe that our industry and, within its framework, our institute can now begin to bestow some such reward on our friends throughout the world.



Germany and the Oil industry



Ludwig Erhard
Minister of Economics
Federal Republic of Germany

THIS Fifth World Petroleum Congress will again be of the greatest significance for countries interested in the mineral oil economy. For in an epoch during which atomic energy is of growing importance and begins to govern all sectors of the power economy, for many, if not most nations, the economic and technical problems of oil exploitation and of the whole mineral oil economy continue and will certainly remain with us for a long time to come.

The World Petroleum Congress 1959 in New York is now taking place in connection with the centenary of the oil industry in the U.S.A. The rise is remarkable which industry and living standards in the United States owe to oil, especially if it is taken into consideration that the steep ascent of the production rate took place only towards the end of the nineteenth century, with the invention of the internal combustion engine. Favored by the size of its oil fields, the United States has developed into the prime oil producer and consumer of the world.

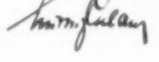
One year before the discovery of oil by Colonel Drake at Titusville, the first well was sunk in Germany, at Celle. During the succeeding hundred years, the German oil exploration has been continuously intensified. Owing to geological conditions in Germany, however, only small fields have been discovered which are difficult to exploit; therefore, production has only attained a fraction of the American output. Nevertheless, the Federal Republic with her 4.4 million tons of annual output is the chief oil producing country in Western Europe and ranges among the principal oil consumers of Western Europe. The demand of the Federal Republic is covered approximately a third by domestic production.

The importance of national resources at times when supplies from outside are hard to obtain has been demonstrated in the years between the Fourth World Petroleum Congress and the present one. During the Suez crisis, it was oil exploitation from the German subsurface which helped considerably to overcome the difficulties of supply in the Federal Republic.

Meanwhile, the oil exploitation of the world has been further intensified. Even though nuclear energy may be at the disposal of the consumer at economic prices in the future, oil will still maintain its importance, considering its numerous possible uses as liquid fuel and as lubricating oil and also as base material for steadily growing sectors of the chemical industry.

However, crude oil will not infinitely remain at the disposal of mankind. Some parts of the world may still yield great reserves to be discovered in the years to come. Because of the present state of scientific research however, these reserves are limited. In consideration of the continuously rising demand it is therefore inevitable in the future, to search for and to exploit workable deposits by application of all available modern methods which science and technique offer.

The significance of the German contribution to the Fifth World Petroleum Congress is demonstrated by the scientific treatises which have been accepted by the permanent council of the World Petroleum Congress, and whose main purpose is to arrive at new knowledge of a wide variety that can be evaluated under technical and economic aspects. May they contribute to the well-being of nations and to their peaceful cooperation!



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Geophysical and Geological Exploration

Oil training in Germany

The various possibilities of education in petroleum science, technology and economics

by Dr. H. C. Gunther Schlicht, Hamburg

For many centuries, the German people, like other European nations, has had a tradition in the domain of Arts and Sciences. In the sphere of technology, German specialists have also made fundamental contributions to the existing high standard. They have, in particular, taken an active part in the development of the science of petroleum. The name of Engler who, together with his congenial Austrian colleague Hoefer wrote the first standard book on petroleum, is an outstanding example.

It is characteristic of the method by which scientific knowledge is gained and taught in Germany that there is in principle no separation between research and teaching. The German has a strong desire for individual intellectual activity which, in the sphere in question, leads to the fact that the various special branches of petroleum science and technology are not taught at one single scientific center but are taken care of by a multitude of well-known scientists working with many universities and research institutes. It is therefore possible to obtain a fundamental training at the German universities, technical universities and technical schools. Advanced and specialist training can be obtained at numerous special institutes and within the industry itself.

The whole subject which is being dealt with here, will best be subdivided into the following sections:

exploration, production, processing including petrochemistry, distribution, utilization, and research.

All these sections should first be further defined in order to show what professional training is necessary for every single section. Then, the training institutions will be dealt with, viz. those of the middle and university grade, and finally some specific questions of training will be discussed which may be of importance for non German students.

A. Sections of the petroleum industry.

1. Oil exploration. Geology and geophysics are subjects being read at universities and technical universities. Necessary supplementary subjects are mineralogy, petrography, paleontology as well as chemistry, physics, mathematics or combinations of these subjects. Special study in oil geology is not required; on the contrary, great importance is attached to the fact that general geological training should be as broad as possible. Additionally, there is a special training of geodesy, and the students must gain sufficient practical experience with geophysical methods and equipment and with general measuring and instrumental matters.

It is a recognized fact that only the drill bit brings about the final result of any exploration activity. There is no special training in Germany for deep drilling engineers. In the training schedules of mining academies and technical universities with mining branches, however, special lectures and practical courses on deep drilling and related questions are included for a supplementary training. There is no special training on this subject during the university period. After graduation only, certificated engineers (mining or mechanical) may obtain two years practical training as drilling engineers from oil companies. During this training period, the young engineers, apart from actually working with a drill crew, are introduced, in periods of several months each, into the various activities related to deep drilling. For drillers and drilling superintendents, however, there exists a special drillers' school (Bohrmeisterschule) at Celle, which will be dealt with later-on.

In exploration, not only the knowledge of the various branches of natural sciences is required but also the lawyer with special training, since the matter of legal contracts, especially with regard to exploration and exploitation concessions, is of the most vital importance for the development of any oil company and, moreover, of the whole oil industry.

2. Production (exploitation) of oil. In the production section, a great number of technical professions are required in view of the intense specialization and high engineering standards of this section.

In general oilfield planning, based upon reservoir conditions, geologists, mining engineers or physicists with special training in sediment petrography, mathematics and physics, and scientific management are employed. Mechanical and mining engineers are reponsible for the drilling of deep wells and the selection of underground or aboveground production and field processing plants (e.g., gas separators, stabilizers, clearing and desalting equipment measuring apparatus, pump and compressor stations, workshops, tanks, pipelines etc.). Civil and electrical engineers, chemists, material specialists are among the many other professions which are also needed. They may have graduated from a university or technical university or from a technical school. Moreover, specialists for scientific management and—now at a growing rate also in Germany—plant economy coordinators are required, i.e. specialists for coordinating the crossing lines and bordering interest of technique and economics This is of major importance in view of the great number of technical and management tasks. Without these coordinators, any economic production would now be inconceivable.

Generally speaking, there will be almost no professional branch for which there is no possibility or even necessity of employment in the sphere of oil production.

3. Processing, refining, and petrochemistry. Processing is generally defined as the manufacture of the various oil products by means of the conventional methods of distillation, refining, cracking, reforming etc. But in Germany, there is also a considerable synthetic production by hydrogenation.

Crude oil, usually already purified and stabilized in the oil field, is transported to the refinery mostly by pipeline and by tank car. Here begins the complicated path of the crude oil to the finished product which leads through a multitude of intermediate stages and semiproducts. As a rule, the production of petrochemical base stock, in the first line of olefins, takes place during the normal refining process, but for polymerization and production of finished petrochemical products (synthetic plastics etc.) there are special plants which are built either adjacent to oil refineries or separately. These plants are planned and constructed by process engineers, chemists and apparatus engineers. The building is normally carried out in cooperation with special engineering firms, which are closely connected to the apparatus construction industry, but the planning team remains in charge of building control and supervision.

The managers of refineries and petrochemical plants are mostly chemists, having at their disposal a staff of scientists ranging over a wide scale of various professions the most important of which are, e.g., physicists, electrical and mechanical engineers, equipment and apparatus engineers and practical chemists. It is well known that in a modern refinery, there is a great variety of processes, such as atmospheric and vacuum destillation, cracking, polymerization, Platforming, desulfurization, dewaxing, solvent refining and other methods for the refining of lubricants. Furthermore, there are laboratories, testing plants, workshops, and equipment for the production of petrochemical base stock. Consequently, the training of the refinery staff must cover a wide range of different specifications and tasks.

4. Distribution. A very versatile organization is necessary to cover the demand for petroleum products. Especially the main products gasoline, gas oil, lubricating oil, fuel oil and road bitumen require a great many tank farms, tanks for intermediate storage, gasoline stations, marine bunkering stations, airport fuelling equipment etc. In addition, transportation by road, rail and waterway must be provided. Because of the fire risk, which often is very considerable, the personnel who plan and control transport of marketing facilities and who directly handle petroleum products, must be fully informed about the relevant laws and protective regulations. Also in the marketing section, chemists and engineers of all kinds are employed.

5. Utilization. In this section, there is a broad field for scientists of almost all branches. The petroleum industry has set up a widespread service where many engineers, physicists, chemists and economists are employed. Nowadays, the consumer is no longer in a position to select for himself the right product for a special purpose. He needs advice by the oil industry about the many possible uses of oil products. The difficulty of selecting the right lubricant, or the great variety of products in the field of petrochemicals are only two examples for the necessity of special knowledge of the expert.

6. Research. Technical development is racing forward at an ever growing speed. It is vital to keep pace! Consequently, there is no oil company of standing which has not built its own scientific laboratories and research institutions. Space forbids giving more than a hint of the extraordinarily great number of problems to be solved with the aid of *scientists ranging in the whole scale of natural science branches.* The importance of the lawyer has already been mentioned in connection with the example of concessions. The physician with special training has not only to look after the drilling and production crews working under bad conditions of climate, particularly in tropical countries. His knowledge is also needed for the development of pharmaceutical and cosmetic products from oil derivatives. There being certain relations between the quantities of the various oil products to be produced from crude oil, the vast province of marketing research is of fundamental importance for the oil industry; it is taken care of by economists and specialists for scientific management.

B. Details of oil training.

1. The middle grade: Engineering schools (Ingenieurschulen) higher technical State-schools (höhere technische Staatslehranstalten) etc. In the mechanical, electrical and similar industries 4 to 5 times as many middle grade engineers are required as engineers with university education. The talent for leadership not being a question of training but of personality and character, the middle grade engineer, too, has every possibility of promotion, even to the highest positions. Consequently, the more practical minded young men should attend the a.m. engineering schools.

The training there is of the college type, thus meeting the more practical inclination of the student. As to the preparatory education, the school certificate examination of a lower secondary school with 10 forms is required. Young men with elementary school education only may be admitted if they have completed their apprenticeship as skilled workmen and have brought their general education, by any means they choose, up to the standard of the a.m. school certificate.

It is supposed that any student of an engineering school or a similar college has, before beginning his training there, successfully done practical work for two years, if possible even finished three or three and a half years of apprenticeship as a skilled workman with an industrial enterprise of the respective professional line. The time at college then amounts to 5 or 6 half-year terms.

Possibilities of obtaining the theoretical and practical training for middle grade technical jobs in the deep drilling and mining industries, i.e. training for driller, master miner, works superintendent, differ from the a.m. way of professional training and will be discussed later on in chapter D.

2. Academic education. In Germany, no one may, in principle, be admitted to a university or equivalent institution without the leaving certificate of a first grade secondary school with 13 forms (certificate of maturity). The students are left a high degree of liberty how to conduct their studies. There are lectures on the various general matters of instruction and, moreover, practical exercises in laboratories and special advanced classes.

As a rule, universities do not require the students to do or to have done practical work during or before studies, but in the case of technical universities and mining academies, students must complete a practical apprenticeship of one year, either as a whole before beginning studies or six months before matriculation and the rest during the vacations between half year terms.

Very talented young men who have been graduated from a technical school with at least a good report (mark 2) may also be allowed to attend the technical universities.

After four half-year terms, there is a preliminary examination, and after at least eight terms, students may pass the main examination for certified engineer, but usually more than eight terms will be needed for really completing studies.

It is advisable that students, in addition to the apprenticeship prescribed, do some more practical work during vacations in an industrial plant falling into their professioned line in order to supplement their knowledge and experience.

3. Special training. Whoever is interested in obtaining more detailed knowledge of any special branch, will find ample opportunities at numerous institutes of universities, technical universities and research companies. Also the industry often provides a thorough special training for their employees with university or technical school background.

C. The German Education Centers.

1. Engineering schools and similar institutions. For the petroleum industry, the following professional branches, which are taught at German engineering schools, are of interest:

Professional branch	*Number of relevant schools*
Apparatus construction	1
Civil engineering	39
Electrical engineering	31
Precision tool manufacturing and optics	1
Precision mechanics	5
Communications electronics	5
Public utilities (heating, air conditioning, gas and water supply, hygiene)	5
Mechanical engineering	34
Physics	1
Technical chemistry	3
Processing and control technics	2
Geodesy and cartography	9

These engineering schools are scattered in many parts of the German Federal Republic. General information as well as details as to which special branches can be studied at the various schools may be seen from the book "Deutscher Ingenieurschulführer" (published by Verlag Bibliographisches Institut A.G., Mannheim) which is reprinted every year.

2. Universities. Within the boundaries of the German Federal Republic, there exist universities at the following locations: Berlin, Bonn, Erlangen, Frankfurt Main, Freiburg, GieBen, Hamburg Gottingen, Heidelberg, Kiel, Köln, Mainz, Marburg, München, Münster, Saarbrücken Tübinger, Würzburg.

At all a.m. universities, mathematics, physics, chemistry, mineralogy, geology geography with related auxiliary subjects are read, final examinations on these subjects may be passed, and doctors' degrees may be obtained.

3. Technical universities. There are present the follwing technical universities in Western Germany: Aachen, Berlin, Braunschweig, Clausthal, Darmstadt, Hannover, Karlsruhe, München, Stuttgart.

At all these technical universities, the following branches are read: Mathematics, physics, chemistry, civil, mechanical and electrical engineering, and (with the exception of Berlin) also geology. In Aachen and Berlin, there are special mining and metallurgical branches so that these technical universities are at the same time mining academies, whereas at Clausthal, there is an independent specialized mining academy. It may be mentioned here that the technical university in Berlin-Charlottenburg has a special character in as much as the technical and natural scientific training is supplemented in a high degree by a general scientific and academic education.

At the mining academy of Clausthal, there are special branches for mining and metallurgical engineering and underground surveying. Also gologists and geophysicists may get a full training (see also the special paragraph "mining"). A thorough supplementary training in petroleum is provided there by the professorial chair of deep drilling and oil production and the petroleum institute.

On passing the final examination at the technical universities and the mining academy, the student is entitled to the grade of "Dipl.-Ing." (certified engineer) and he may also obtain a doctor's degree as "Dr.-Ing."

D. Some remarks on specialist training.

1. Geophysics and geology. Oil geophysics, i.e. geophysics aiming at finding petroleum reservoirs, are read at the universities of Göttingen and Berlin and at the mining academy of Clausthal, oil geology at the universities of Göttingen and Hamburg, at the technical universities of Berlin and Hannover, and at the mining academy of Clausthal.

2. Mining. In the German mining industry any miner may make his way up to the position of a middle grade superior. The training comprises four steps:

1. Practical work as miner and training at miners' professional schools.

2. Attendance at miners' secondary schools together with further practical work.

3. Training at mining schools for mining, machinery or surveying foreman.

4. Training in the upper forms of mining schools for mine superintendent.

There are mining schools at Aachen, Bochum, Clausthal, Dillenburg, Dortmund, Essen, Hamborn, Hürth nr. Köln, Moers, Recklinghausen, Saarbrücken, and Sigen; those at Aachen, Bochum, and Clausthal have also upper forms. The expenses for this training are covered by the mining companies.

The grade of a certified mining engineer can be obtained, as has been mentioned above, not only from the mining academy at Clausthal Harz, but also from the technical universities at Aachen and Berlin (special oil science at Clausthal and Berlin).

3. Surveying. This branch is read at the technical universities of Berlin, Clausthal, Hannover, Karlsruhe, Munich, Stuttgart, and the university of Bonn. The profession of mining surveying engineering is closely related to that of mining engineer. Therefore, the surveying branch will be found at the same universities as the mining branch.

4. Process engineering. The complex branch of process engineering is read at technical universities. Special mention may be made of the following institutes:

Aachen: Institute of process technology (Institut fü Verfahrenstechnik), chemical engineering institute (Chemisch-Technisches Institut) and institute of fuel chemistry (Institut für Brenn-stoffchemie).

Berlin-Charlottenburg: Chemical engineering institute (Technisch-Chemisches Institut), institute of fuel technology (Institut für Verfahrens- und Kältetechnik).

Braunschweig: Institute of chemical engineering (Institut für Chemische Technologie).

Clausthal: Institute of fuel chemistry and technology (Institut für Brennstoffchemie und Brennstofftechnik).

Darmstadt: Institute of chemical engineering (Institut für Chemische Technologie), institute of heating and drying technology (Institut für Heizungs- und Trockungstechnik).

Hannover: Institute of petroleum research (Institut für Erdölforschung).

Karlsruhe: Institute of apparatus engineering and process technology (Institut für Apparatebau und Verfahrenstechnik), and Carl Engler- Hans Bunte-institute of petroleum and coal research (Carl Engler- Hans Bunte-Institut für Mineralöl- und Kohleforschung).

München: Chair of process technology (Lehrstuhl für Verfahrenstechnik), Institute of chemical engineering (Institut für Chemische Technologie) and department of aviation fuels and lubricants of the German aviation research institute (Institut für Flugtreib- und Schmierstoffe der Deutschen Versuchsanstalt für Luftfahrt).

Mülheim/Ruhr: Max Planck institute of coal research (Max Planck-Institut für Kohleforschung).

Dortmund: Institute of spectrochemistry and applied spectroscopy (Institut für Spektrochemie und angewandte Spektroskopie).

5. Deep drilling. Young men with elementary school education are given special possibility of becoming deep drilling or petroleum production engineers by the Master drillers' school (Bohrmeisterschule) at Celle. Whoever has terminated his apprencticeship as driller and has proved to be an able worker, may be sent by his company to a course of lectures for gang foremen. Any capable gang foreman may be promoted, after a further course of instruction, to master driller or production master. On the other hand, he may be admitted, after one or two years practical work as gang foreman, to an engineering school, to become a professional engineer after five or 6 half-year terms.

E. The training of foreign students in Germany.

It is an important prerequisite for successful training in Germany that students have a good knowledge of the German language. Usually, students make the easiest and best progress in mastering the German language by making use of the outstanding facilities of the Goethe Institute,[1] which operates linguistic schools at many locations in Germany and abroad.

For young foreigners doing practical work in Germany, the Carl Duisberg Society[2] has set up a foreigners' service with training programs. It is the aim of the Carl Duisberg Society, the name of which is derived from Carl Duisberg, a scientist and economist who, after World War I, gave his special interest to the exchange of students and trainees, that foreign guests feel at home in Germany. Besides the main office at Köln, there are six local offices of the Carl Duisberg Society at various German towns and in Berlin. Its program is carried out in 24 foreigner circles. The Carl Duisberg Society is supported by the German Foreign Office and other Federal Ministries, the head organizations of the German industry, the trade unions and the German Board of Industry and Trade.

The German students exchange organization[3] assists foreign students in finding positions. Other foreigners may obtain jobs with the aid of the Central Office for Labor Exchange and Exchange-Coordination (Zentralstelle für Arbeitsvermittlung und Vermittlungsausgleich) at Frankfurt Main.

The German industry does its utmost in order to provide paid work for foreigners wanting to gain practical experience. Besides, the vocational guidance departments of labor offices at university towns and elsewhere are glad to give every information regarding matters of education and profession. Special questions as to the various professional schools, universities and institutes, will be answered by the secretaries of these institutions. At all universities, there are foreigners' bureaus which take care of foreign students, assist them in finding rooms and furnish every possible information.

The German diplomatic representatives abroad may obtain scholarships for suitable applicants who want to study in Germany.

Within the limits of this short survey, it was only possible to give the most important hints. It would require a whole book to completely list all training facilities in Germany. To summarize, it would appear that it is worth while to obtain a professional education in Germany. The training is given in the most thorough way, thus securing the student an excellent basis for his further professional life.

---

1 Address of the main office: München 2, Maximiliansplatz 12 III
2 Address of the central office: Köln, Kaiser-Friedrich-Ufer 41
3 Address: Deutscher Akademischer Austauschdienst, Praktikantenamt, Bonn, Nassestr. 11

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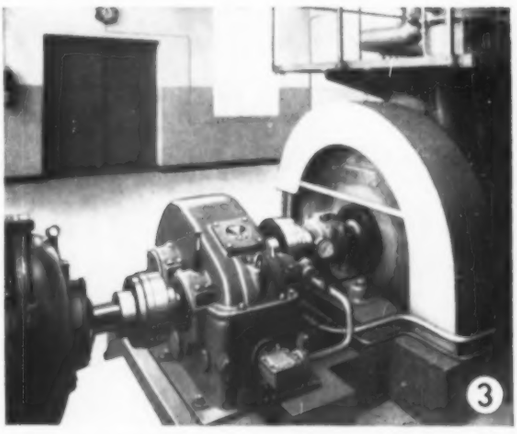

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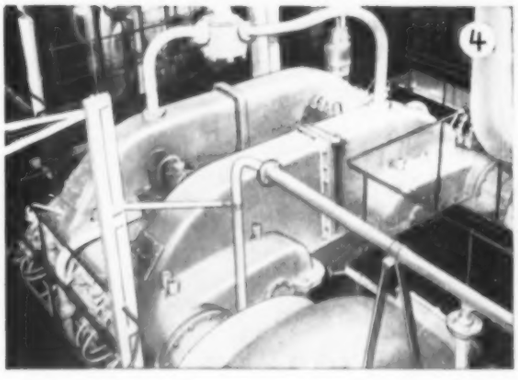

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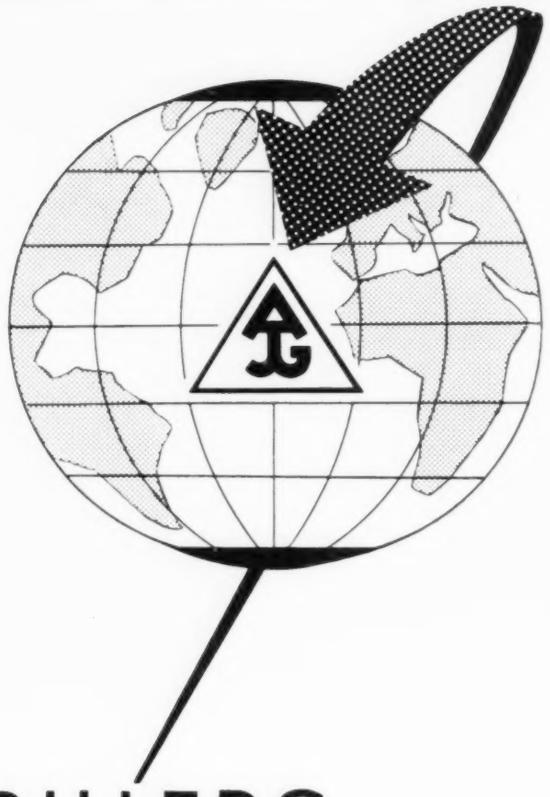

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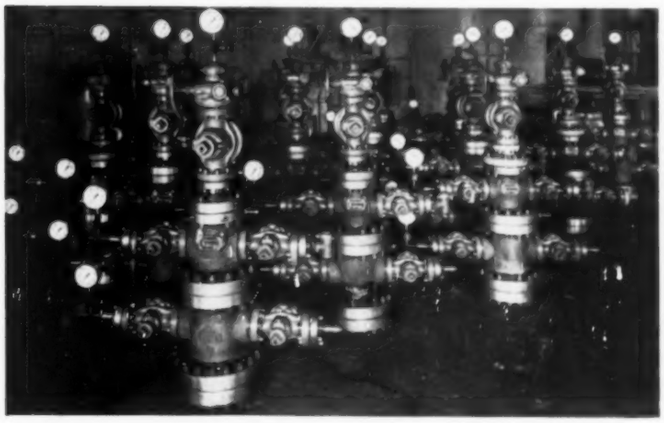

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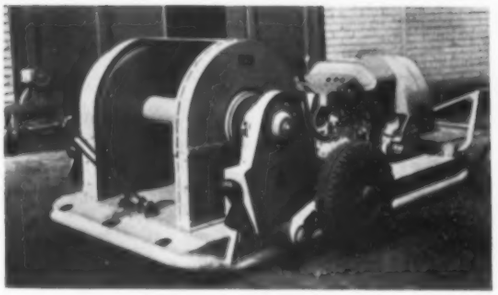

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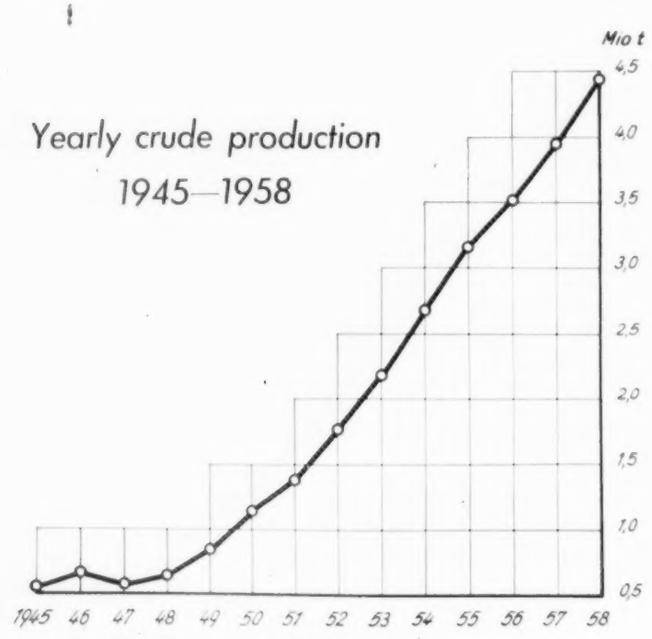
The Development of Crude Oil and Natural Gas Production in the Federal Republic of Germany

by Dr. H. Pfefferkorn, Wirtschafts Verband Erdoel Gewinnung e. v. Hannover

The history of crude oil production in Germany began in 1858/59 with the drilling of the so-called Hunäus-well, which was located in the vicinity of a tar-pit in the region of the present Wietze oil field. Here, for the first time, crude oil—though a few barrels only—was bailed from a depth of 36.6 m.

This discovery was followed, rather hesitatingly, by further drilling operations in the neighborhood of the discovery well. A flowing well was completed there during 1885, resulting in a daily output of approximately 29 tons. Some other surface showings such as oil seepages encouraged further drilling operations. So drilling campaigns were started in 1860 in the vicinity of Hänigsen and during 1862 in the Oedesse-Ölheim district, both of which resulted in small production.

In the 1880s a small producing well was drilled in Tegernsee, a village in the northern outskirts of the Alps. Though of important historical significance these discoveries of the early days of the search for oil in Germany cannot be considered as a real industrialized production with commercial results. An exception may by the Wietze field. Numerous closely spaced wells owned by a great number of operators strongly competing against each other, caused such a rise in production that the output of the Wietze field reached 27,000 tons per year in 1900.



Development on a larger scale was not achieved before the first decade of this century. During the year 1904 the Nienhagen field was discovered and remained the most important oil field for many years. Statistics for the year 1910, for instance, show the following annual production figures:

Field:	*tons/year:*
Wietze	91,283
Nienhagen	18,666
Oedesse-Ölheim	1,047
Tegernsee	680

Important steps during the development of the following period were the sinking of the oil-shaft at Wietze, which started production during 1920, with an initial oil output of 295 tons, as well as the discovery of the Oberg oil field mentioned for the first time in the statistics of 1919.

During the same period development-work was carried out in the area of Heide in Holstein.

In 1930, the number of producing oilfields was still limited to the five following "classical" fields:

Field:	*tons/year:*
Wietze	61,077
Oedesse-Ölheim	14,181
Tegernsee	17
Nienhagen	83,772
Oberg	10,562

The beginning of the 1930s can be looked upon as the period of the intensification of oil exploration in Germany. Reform of the mineral oil law, introduced in the year 1934 for the areas in what formerly was Prussia became effective in this period. Under this law the ownership by the State of all mineral oil rights was established with the exception of already existing lease contracts with land-owners. Improved scientific and technical advancements, extensive geophysical field work combined with geological interpretation as well as capital investment on a large scale resulted in more and more discoveries so that the number of producing fields rose to 21 in 1940, and the annual production exceeded one million tons for the first time. The major part of this production was supplied by the Nienhagen (277,322t), Heide (231,347t) and Reitbrook (357,222t) fields.

The year 1943 brought the discovery of the oil horizons of the Emsland, the following fields of which experienced the greatest postwar development: Georgsdorf, Emlichheim, Rühlermoor and Rühlertwist.

A continuous increase in the number of new producing fields as well as total production began in 1950, finally leading to a total of 4,431,596 tons from 82 fields in 1958.

Year	Oil fields	Production
1930	5	174,070 t
1935	11	427,362 t
1940	21	1,056,238 t
1945	28	547,453 t
1950	39	1,118,633 t
1951	40	1,366,685 t
1952	41	1,755,406 t
1953	48	2,188,696 t
1954	61	2,666,314 t
1955	70	3,147,234 t
1956	83	3,506,219 t
1957	81	3,959,641 t
1958	82	4,431,596 t

The rising trend can also be seen from the annually published estimates of reserves compiled by company experts together with the AMT FUER BODENFORSCHUNG. A tabulation of estimated reserves for the different years follows.

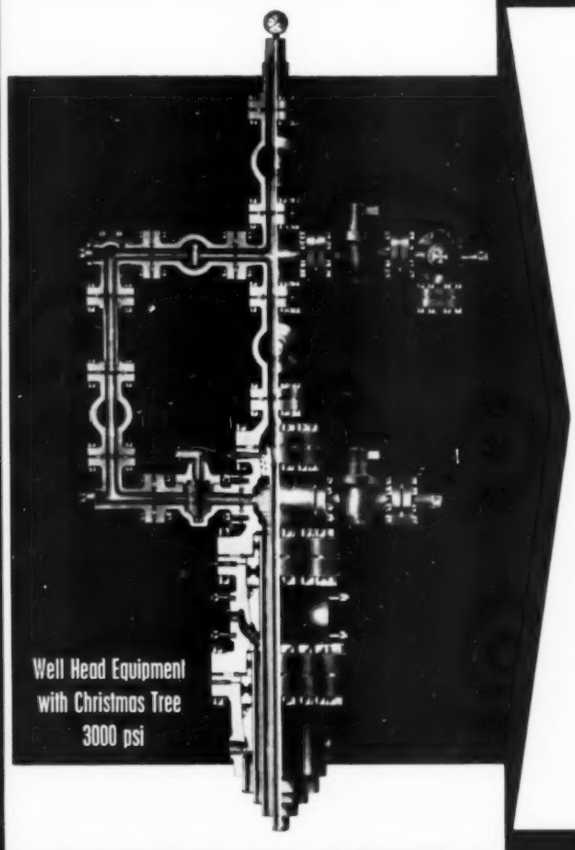
Year	proven	probable
1947	6,188,000	4,410,000
1949	10,334,000	9,865,000
1950	21,704,000	14,796,000
1952	27,884,000	12,831,000
1954	40,867,000	14,225,000
1956	49,078,000	15,960,000
1958	53,395,000	15,391,000

At first wet natural gas produced with the crude oil was used only for internal purposes of servicing such as heating, driving of engines, or as input for small carbon plants. Later, however, the discovery of the first natural gas field (dry gas) at Bentheim, led to industrial utilization. Continuous deliveries of natural gas have been obtained from this field since 1944 following the completion of an 80km pipeline.

Efforts of the German oil industry to contribute primary energy sources to the continuously increasing needs of the country proved successful in recent years. In different areas of the Federal Republic of Germany such as the North German Plains the Rhine Valley and the northern region of the Alps, new natural gas fields were continuously discovered and prepared for economic use during the years 1951-1958. At present there are in operation 15 structurally independent natural gas fields with approximately 70 producing dry gas wells. The combined yearly gas production of fields in millions of cubic meters is shown by the following tabulation:

1952	56
1953	58
1954	87
1955	239
1956	367
1957	357
1958	344

The reason for the decline in output of the last two years is explained by the temporary decreasing needs of consumers, and is not due to the field potentialities.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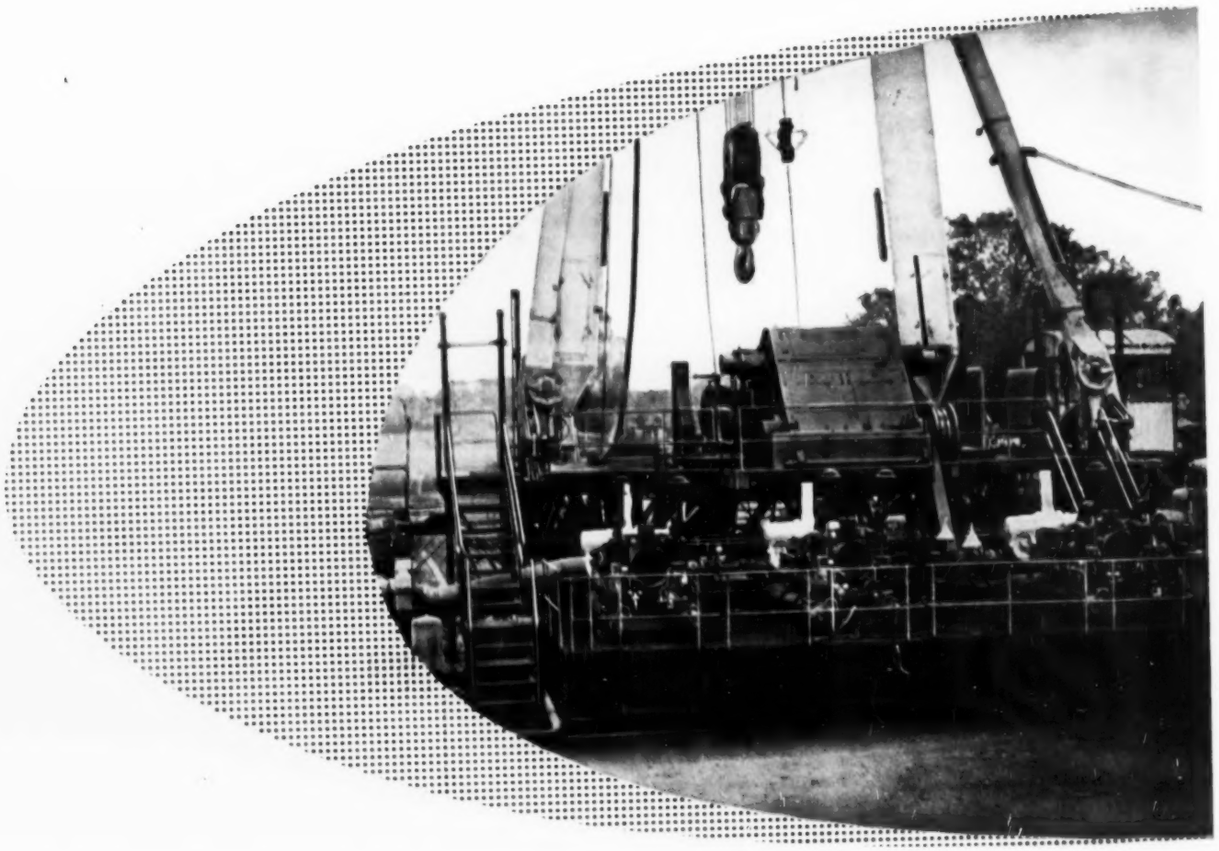

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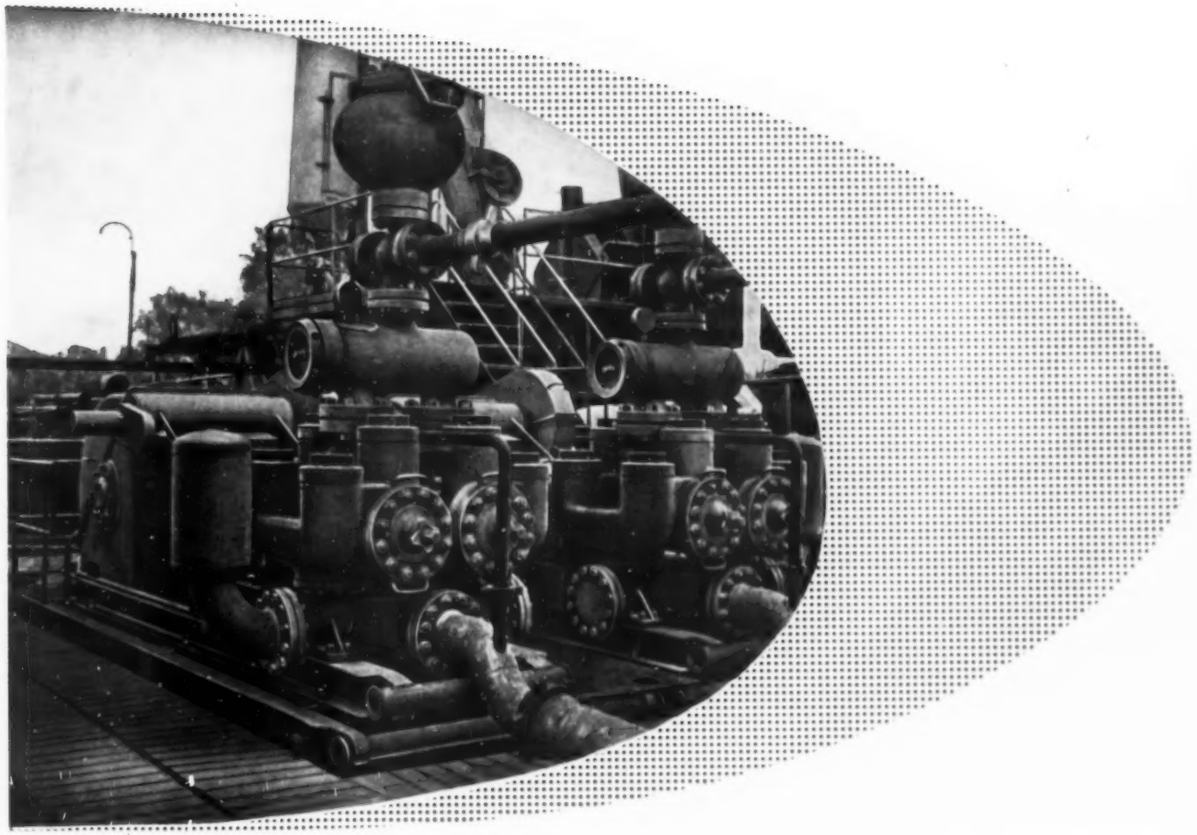

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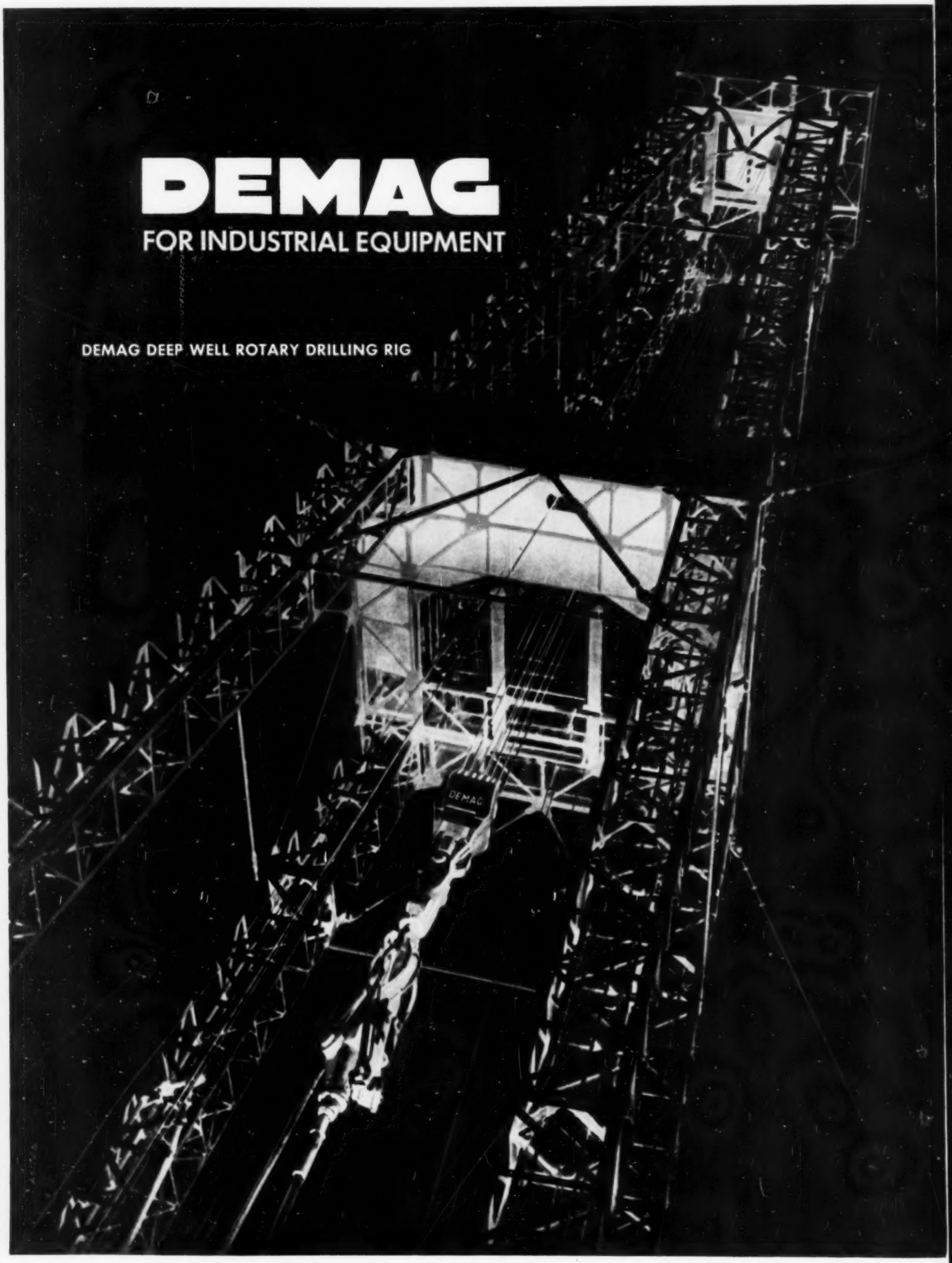

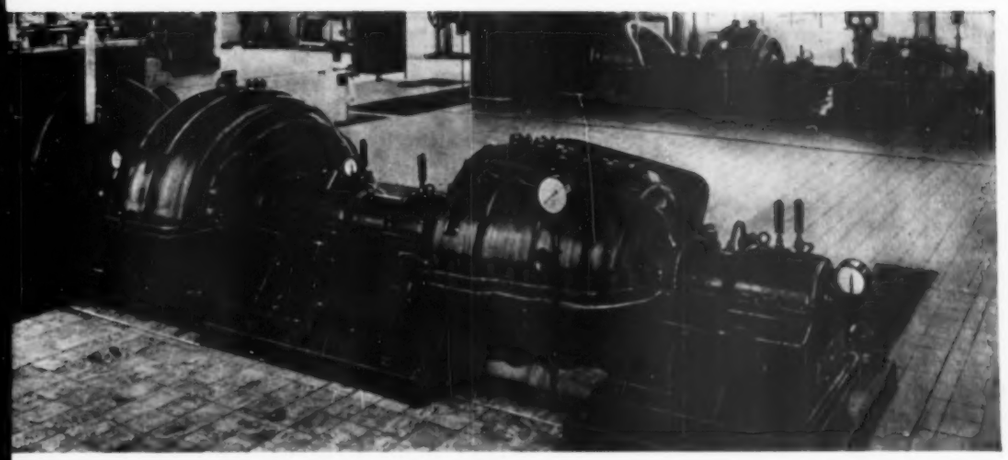

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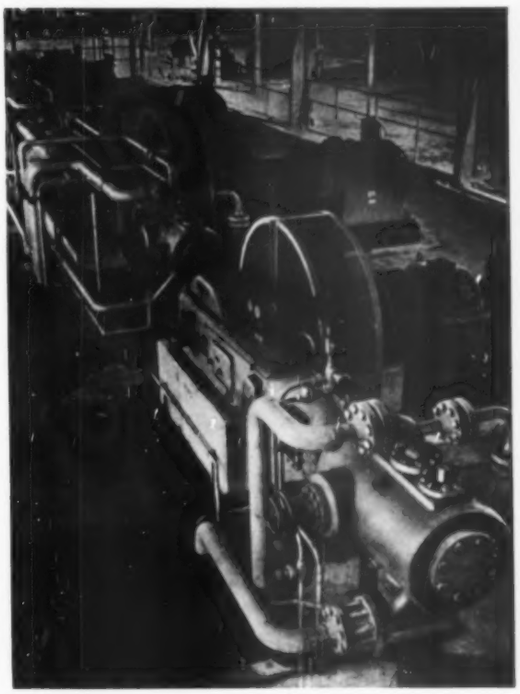

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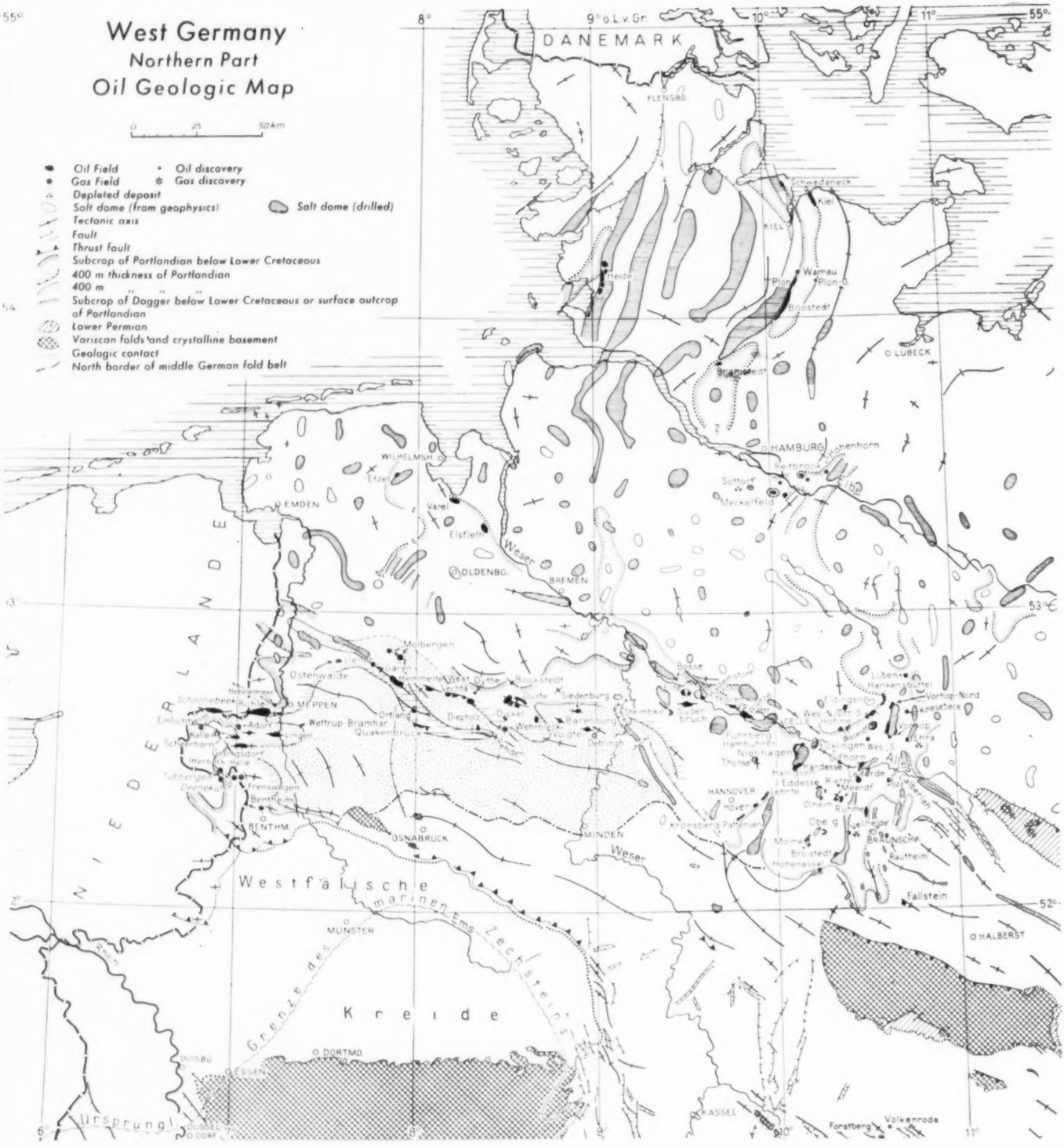

West Germany
Northern Part
Oil Geologic Map
0 25 50km
Oil Field
Gas Field
Depleted deposit
Salt dome (from geophysics)
Tectonic axis
Fault
Thrust fault
Subcrop of Portlandian below Lower Cretaceous
400 m thickness of Portlandian
400 m " " "
Subcrop of Dogger below Lower Cretaceous or surface outcrop of Portlandian
Lower Permian
Variscan folds and crystalline basement
Geologic contact
North border of middle German fold belt
Oil discovery
Gas discovery
Salt dome (drilled)
DANEMARK
FLENSBG
KIEL
LUBECK
HAMBURG
WILHELMSH
EMDEN
OLDENBG
BREMEN
MEPPEN
OSNABRUCK
MINDEN
HANNOVER
BRAUNSCHW
HALBERST
MUNSTER
BIELEFELD
DORTMD
ESSEN
DUISBG
DUSSLDF
KASSEL
Westfälische
Kreide
Niederlande
Ursprung
Grenze des marinen Zechsteins
Weser
Ems
Rhein

Types of Oil and Natural Gas Deposits in West Germany

by Dr. F. Kühne

Federal Institute for Exploration of Natural Resources

Introduction: Oil and gas deposits are bound to troughs with non-metamorphous sedimentary layers of great thickness which have not been too intensely folded. The structures for oil accumulation must be formed by gentle folding and transgressive overlap causing fractures as well as facies change. Also swellings formed after the migration of salt, salt domes and diapirs piercing through overlying horizons create such structures.

In Germany, these conditions for the origin of oil and gas deposits exist in:

1. Northwest Germany.
2. The Rhine valley-graben.
3. The Molasse Trough (Foreland of the Alps).

1. Northwest Germany (see Fig. 1).

In Northwest Germany, north of the margin of the mountains of Central Germany, a deep basin lies below the deposits of the glacial period and the marine Tertiary beds. This basin was filled up with thick sediments of the Cretaceous, the Jurassic, and the Triassic. Below the upper stratigraphic stages lies a horizon with sediments of the Upper and Lower Permian (lower stages). In the southern part up to a line Wilhelmshaven-Hamburg, the lower Permian is developed in a continental facies. North of this line it is mostly formed by evaporites. The Upper Permian or the Zechstein is also formed by evaporites and is well-known for its various potash deposits which are exploited by numerous mines. So far known Carboniferous and Devonian beds lie underneath the Permian.

In this Northwest German basin the Jurassic and the Lower Cretaceous beds differ considerably in thickness. Oil deposits occur where the beds of these formations have attained their greatest thickness. This happens in the southern and eastern part of the basin as well as north of the Elbe river in west and east Schleswig-Holstein.

In this region, the folding and faulting of the Saxonian tectonics have produced: (a) type of anticlinal structures (Fig. 2) of the Emsland, west of the Ems river, and (b) in the area between the Ems and Weser rivers, a very complex type of structures partly associated with overthrusts. Here, salt migration plays a subordinate role. Salt domes or diapirs have not been formed in areas where anticlines exist. There unconformity traps as well as such ones due to facies changes occur (see Fig. 3).

East of the Weser, along the Aller river and between the Harz Mountains in the northwest and the Elbe river, salt domes are encountered in areas with thick Jurassic and Lower Cretaceous sediments. The oldest oil fields of Germany: Wietze, Nienhagen, Eddesse-Olheim and Oberg have been found on the flanks of salt domes. Since 1949 also other types of oil accumulations have been found. These include the anticlinal fields of Suderbruch and Eldingen (see Fig. 4) which lie in regions formerly considered as areas of depression between salt domes.

During earlier exploration also oil accumulations in traps formed by the overlap of the Albian of the upper Lower Cretaceous have attained considerable significance. To this category belong the Lehrte, Hohne and Handensbüttel-Örrel fields which are situated at the edges of the Dogger troughs. The largest fields on top of a salt dome is the Reitbrook oil field in the Lower Elbe area. The salt dome lies at a depth of 850 m, and the field produces from overlying horizons of the Upper Cretaceous.

North of the Elbe river complexly folded diapirs have been formed by the evaporites of the Zechstein and the Rotliegend. (Haselgebirge). Both formations have horizons of salt and other evaporites which strike over wide distances from southsouthwest to northnorthwest. On the western flank of such a salt uplift, in western Schleswig Holstein the Heide oil field lies at the eastern margin of a deep Dogger trough. Long before the discovery of this oil field,

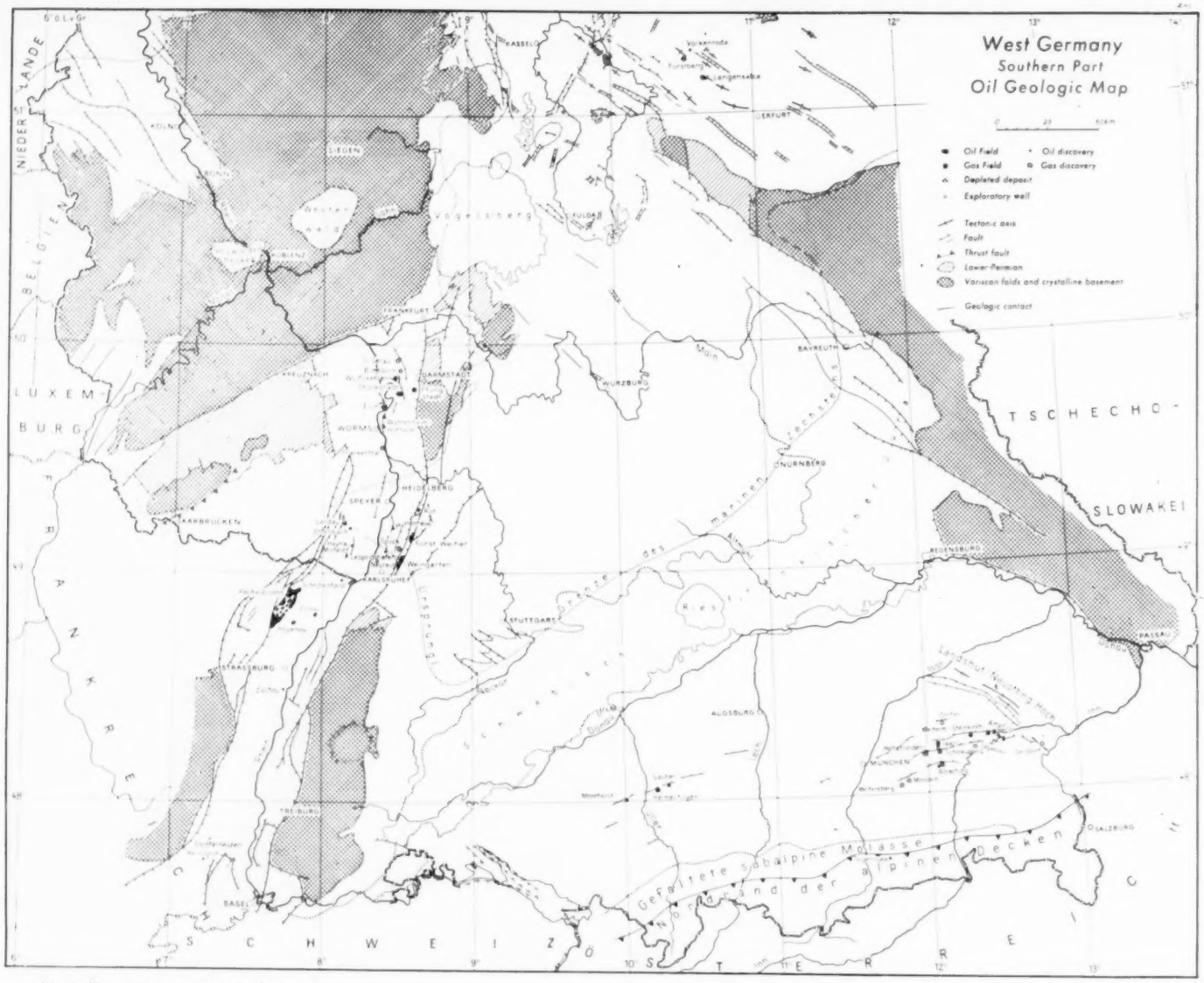


Fig. 5: West Germany, southern part, oil geologic map.

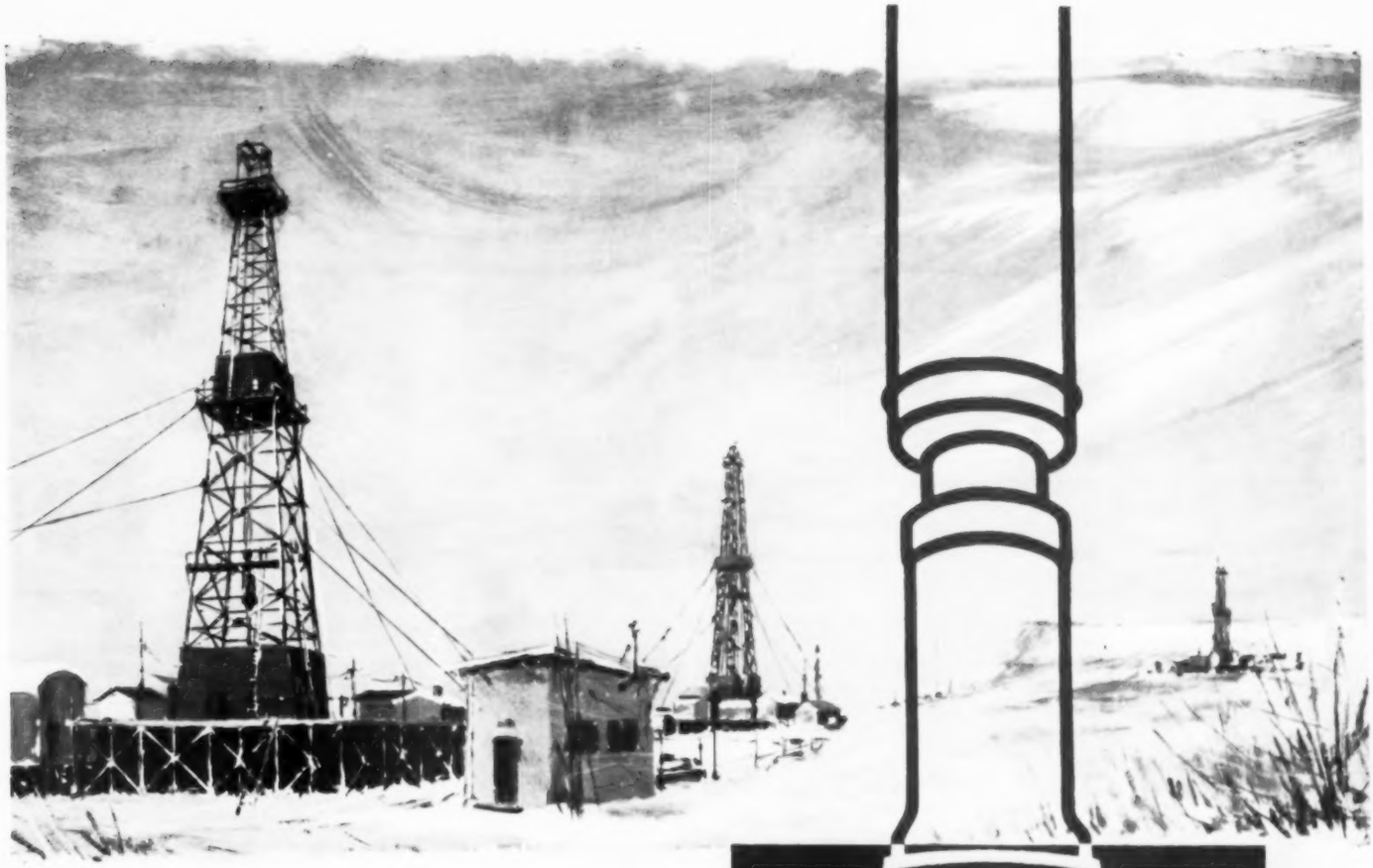
oil chalk was found in the top region of this diapir. In the eastern part of Holstein such a salt diapir runs parallel with a Dogger trough. At his western and eastern margins the oil fields of Bramstedt, Boostedt-Plön, Plön-Ost, Kiel and Schwedeneck are located. The oil of these fields has accumulated in the sandstones of the Dogger which crop out below the overlapping Albian.

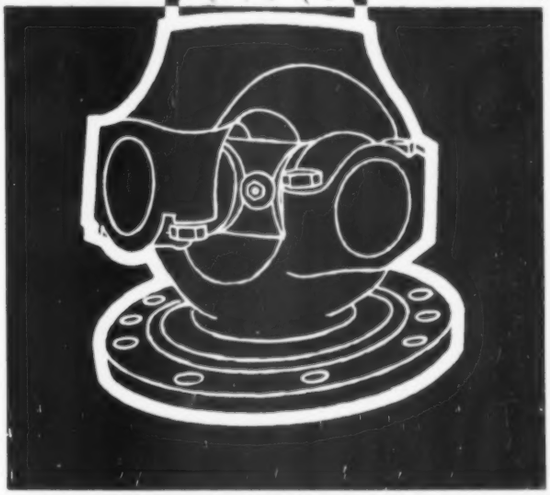
The oil of northwest Germany predominantly occurs in Jurassic and Lower Cretaceous beds. The only exception to this rule is within the Heide oil field where the reservoir rocks of the Lower Zechstein are folded in the salt dome and where, for a short time, oil has even been produced from the beds of the Rotliegend. As for the Jurassic and the Lower Cretaceous beds it has been found that this stage has its own characteristics with regard to stratigraphy, facies and tectonics. This stage is best investigated in northwest Germany where drillings to depths between 1000 and 3000 m are necessary.

The evaporites of the Upper Permian are underlain by the second stage from which gas is produced. Reservoir rocks are mostly dolomites and limestones of the Zechstein 1 and 2 (Werra and Stassfurt series). The most important gas field is the Rehden field (Fig. 3) between the Weser and Ems rivers. Of the five fields known in the Emsland area, the oldest gas field of Bentheim may be mentioned. In Germany the exploration of structures below the Permian is still in its initial development. Drillings down to 3000-6000 m will be necessary.

2. *Rhine Valley-graben (see Fig. 5).*

The Rhine valley is a graben bordered by faults along its western and eastern margins. The graben extends from Basel to Mainz. It has a length of 300 km and is 40 km wide. Only the area between Karlsruhe and Mainz on both sides of the Rhine river belongs to Germany. The southern part of the Westrhenish region belongs to France. Oil and gas bearing beds are of Tertiary age. The deepest part of the graben is near Mannheim, where the Tertiary sediments attain a thickness from 3500 to 4000 m. The sediments are mostly block-faulted. These structures prove good oil and gas reservoirs (see section 6). Early oil exploration was restricted to the marginal block-faulted structures and the Forst-Weiher, Weingarten and Rot fields were discovered along the astern side of the Rhine valley. They produce oil from upward dragged blocks of the reservoir rocks of the Keuper (Upper Trias) and the Lower Jurassic and thus differ from all the other fields. They produce oil from the Lower Tertiary (Oligocene) and gas from the Miocene and Pliocene respectively. In the northern part of the graben as far as the Worms area, Lower Permian (Rotliegendes) underlies Tertiary. Towards the south, the Tertiary is underlain by Jurassic and Triassic sediments. Apart from one wildcat into the Rotliegend, this deep stage so far has not been explored.





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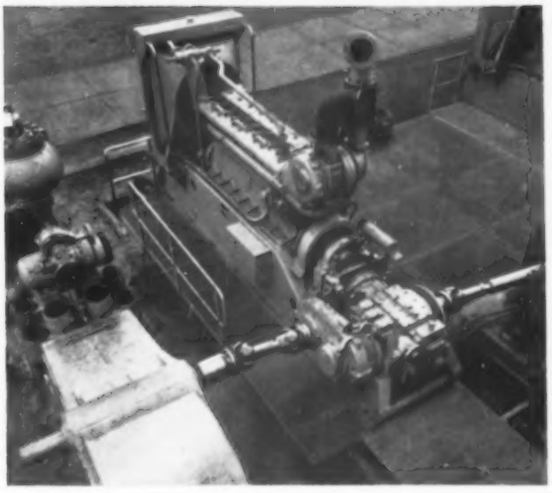

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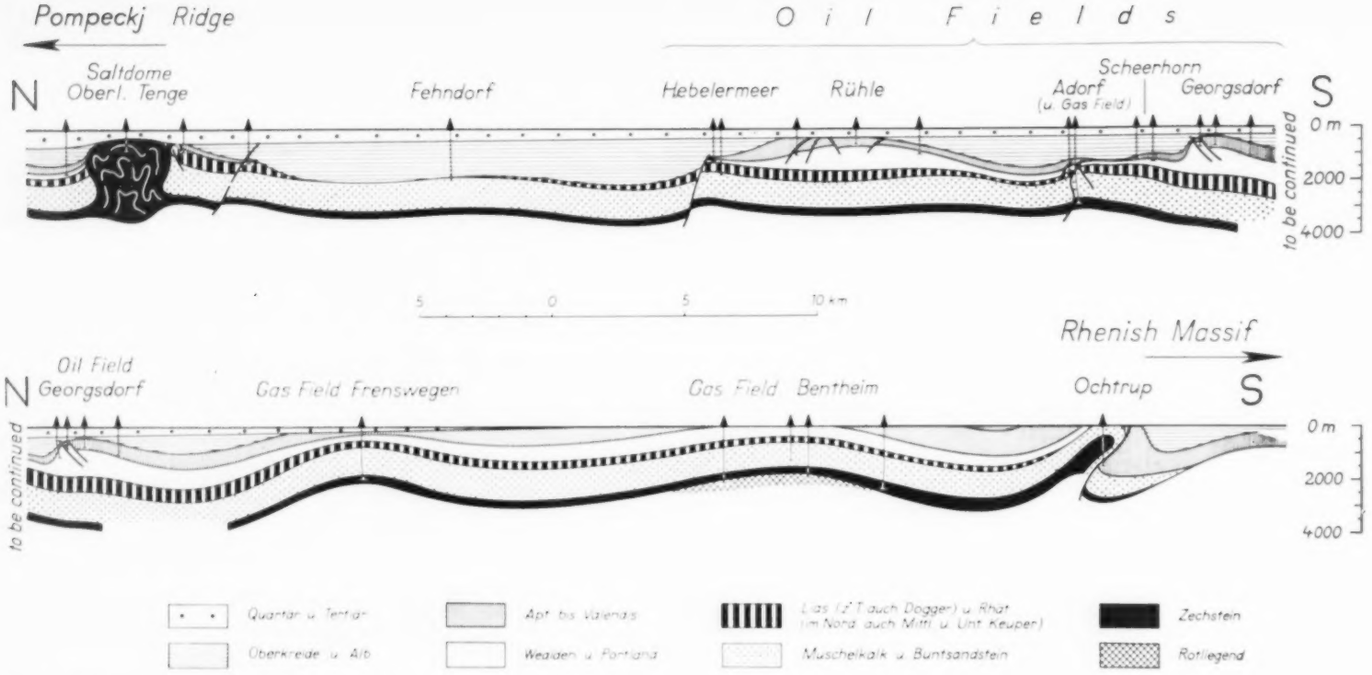

Fig. 2: N-S section through the Oil and Gas Fields of the Emsland area (by H. BOIGK, 1956).

3. *Foreland of the Alps (see Fig. 5).*

A recently explored oil and gas region is the Molasse Basin which is part of a syncline extending in front of the Alps from Austria to Switzerland. In this basin detrital material from the Alps has been deposited. In Germany, the northern ridges of the intensely folded alpinotype orogen is followed to the north by a small zone of the folded Molasse which is bordered by the flat lying Molasse extending up to about the Danube river. In its eastern part the basin has a width of more than 100 km, the beds are of Tertiary age and of a marine and limnic—brackish facies. The deepest part of the syncline is near the margin of the alpine orogen of the Alps where the folded Molasse reaches a thickness of 5000-6000 m. Exposures have proved that the western part of the forelands consists of Malm beds (Upper Jurassic) whereas the eastern part shows mainly beds of the Upper Cretaceous. Towards the southwest the sedimentary complex is followed by beds older than the Upper Cretaceous. Reservoir rocks for oil and gas are the Lithothamnien limestones of Lattorf as well as sand horizons of the Rupel, Chatt and Aquitan-Burdigal. Oil or gas accumulations are associated with faulted structures striking east to west or southwest to northeast. They dip antithetically (Fig. 7). Oil fields discovered up to the present lie in the unfolded Molasse. West of Munich, smaller oil fields have been discovered (Mönchsrot, Heimertingen and Lauben) which produce from the base of the Baustein Beds (sandstone beds) of the Rupel. East of Munich, between Isar and Salzach (see Fig. 5), mainly gas fields have been found. Only Isen and Ampfing produce gas and oil.

Investigations of the folded Molasse have just been started. The results of wildcat Murnau 1 encourage further exploration. The well found very favorable oil and gas indications in the sandstone beds of the Rupel-Chatt (Oligocene).

4. *Retrospect concerning the development of exploration in Germany.*

(a) *Northwest Germany.* Early oil exploration was restricted to the investigation of salt domes because, since 1874, oil has been produced from a new oil field type known as salt dome flank trap. (Compare Fig. 4). The fields of Wietze (since 1874), Eddesse-Ölheim (since 1876), Nienhagen (since 1904) and Oberg (since 1919) became known. In the search for salt dome flank oil fields from 1935-1941, a number of other fields at Heide, Mölme, Gifhorn, Reitbrook, Meckelfeld, Eicklingen-Sandlingen, and Fuhrberg have been discovered. Two of these fields belong to new types: the accumulations

Fig. 3: S-N section through the Oil and Gas Fields Rehden—Düste (by E. BRAND, 1956).

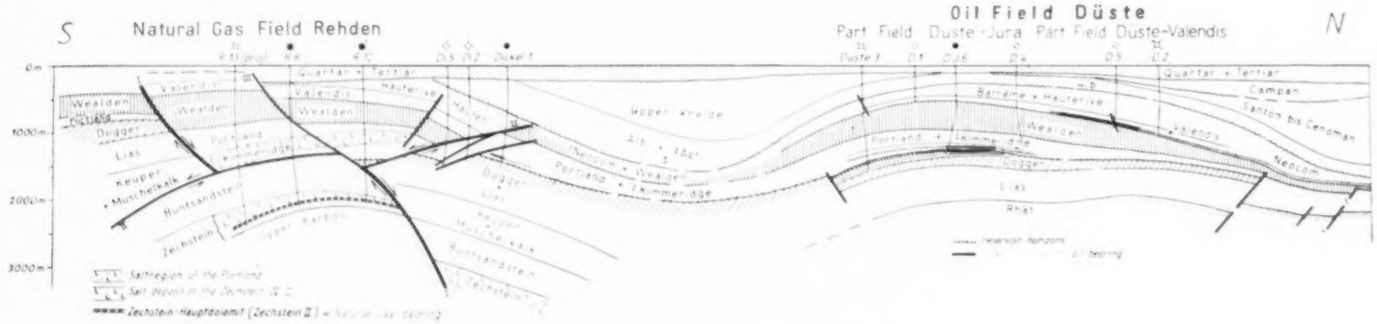

Fig. 4: Oil and Gas deposits in Eastern Niedersachsen (by MALZAHN, SCHOTT, 1953).

in the top region of salt domes (Reitbrook) (see Fig. 4), and the concentration of oil below large salt overhangs (Eicklingen).

In 1941, another type was added to the existing ones. The Lingen-Dalum field is an anticlinal structure (compare Fig. 2). To the same category belong the oil fields at Georgsdorf and Emlichheim (1944), Rühlertwist and Rühlermoor (1949). All these fields lie in the Emsland area.

The discovery of the rich oil bearing anticlinal fields of the Emsland area gave rise to a search for similar structures in regions between saltdomes which formerly had been considered as simple depressions. In 1949, the fields of Suderbruch and Eldingen (see Fig. 4) were discovered. With this new type of oil fields between salt domes, a new exploration epoch commenced which pushed exploration activity at salt domes into the background. Later on it was discovered that stratigraphic trap oil fields exist in the regions between salt domes as well as below the regional overlap of the upper Lower Cretaceous (Albian).

The area without salt domes, between the Weser and Ems rivers was carefully investigated by geophysical methods and in 1951, the Hemmelte-West field was found. In 1953, oil discoveries along fault and overthrust lines were made at Barenburg, Liener, Molbergen, Voigtei and Aldorf. A connection was established between the old Hannovarian oil region East of the Weser and the Emsland west of the Ems river.

The first oil reservoirs at the margins of Dogger troughs were discovered in the Cornbrash sandstones (Dogger epsilon) in 1952. Oil accumulated along the margins of the Dogger troughs meanwhile discovered below the overlap of the upper Lower Cretaceous (Albian). After the discovery of the field Düste (see Fig. 2) in 1954, it became evident for the first time that facies traps exist in Northwest Germany too. A foundation for the present exploration had thus been established.

Investigation of the beds below the evaporites of the Permian, that is the second stage, had already begun in 1938 when the Bentheim gas field was discovered. In 1952 the Rehden field (see Fig. 3) was found which today is the most important gas field of Northwest Germany. Since the Rehden discovery, far greater attention has been paid to the beds underneath the Upper Permian.

(b) *Rhine valley graben.* In the Rhine valley graben oil accumulations only occur on top of the faulted structures. The faults dipping mostly antithetically serve as traps and the accumulation of oil and gas took place in the uppermost horizons. The exploration was as follows: Based upon information obtained from the Pechelbronn oil field at the western marginal fault zone of the graben, the Forst-Weiher field was discovered on the other side of the Rhine valley in 1935. Geophysical investigation proved that the fault-block tectonics also continued within the Rhine valley graben. In search for these structures the first oil and gas field was found at Stockstadt in 1952 (see Fig. 6). Landau, another important oil field, lies at the western margin of the Rhine valley graben. It was discovered in 1935.

(c) *Molasse Basin.* Of the Molasse Basin, as yet only one type of oil field is known which lies in the unfolded northern part. It is the type of oil or gas field that occurs at faults which preponderantly strike east-west and dip antithetically (see Fig. 7). Geophysical and geological work started in 1954 with the discovery of the Isen and Ampfing oil and gas fields. The first oil field in the Baustein-beds

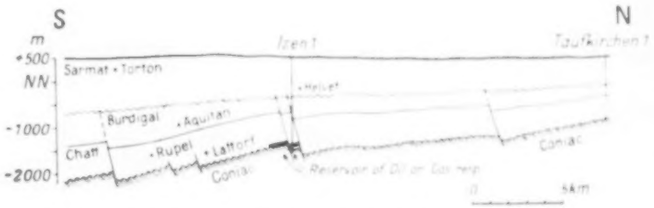

Fig. 6: Section of the Upper Rhine valley (by SIRAUR, 1956).

(sandstone-beds) was discovered east of the Iller river, in 1955. Until 1958, the number of gas discoveries east of Munich was increased by nine other fields.

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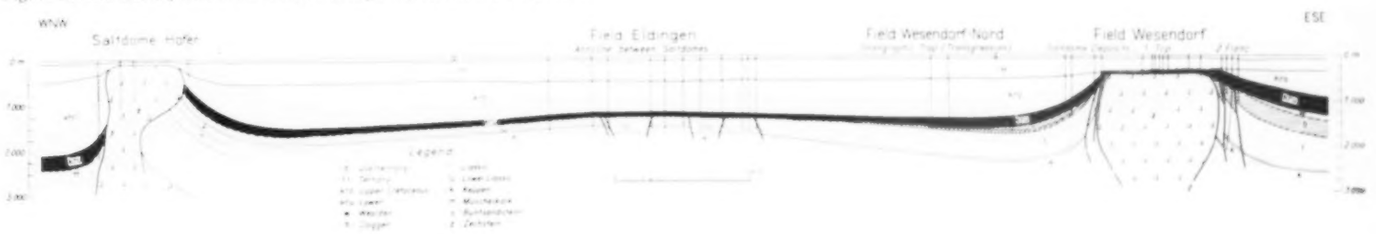
Fig. 7: Oil and Gas deposits of the Molasse Trough (by HEERMANN, 1954).



Rotary Deep Drilling Rigs and Compressors

Figure 1

This rotary drilling rig designed to the unit construction principle is suitable for depths of 6,500 to 20,000 ft and has proved satisfactory during many years of operation in various oil fields. As such rigs are assembled from pre-fabricated parts, it is possible to arrange their layout in accordance with the customers' wishes and local drilling requirements. Particularly useful are the various possibilities of locating the driving units for the drawworks and slush pumps. The ingeniously designed power transmission system by universal joint shafts enables uninterrupted drilling even if one or several of the drilling units should fail. This feature frequently determines the success or failure of a hole being drilled.

Figure 2

These rotary deep drilling rigs have heavyduty gear units instead of the usual chain transmissions. The gear teeth, which are hardened and ground, make the gearings particularly reliable, silent-running and efficient. The rigs are equipped with torque converters having adjustable guide blades and can, therefore, be operated either by diesel or constant speed electric motors (squirrel-cage induction motors). Another economical and operational advantage afforded by the torque converters is the possibility of infinitely varying the speeds and torques. Such equipment complies with recent trends in the oil industry to operate deep drilling rigs only by non-variable electric motors (squirrel-cage induction motors) via torque converters with adjustable guide blades. If no electric power supply is available, the required power current is produced by diesel generator sets.

Depending on the wishes of the clients, the drilling rigs may be equipped with pneumatic or electro-pneumatic controls.

Figure 3

The machinery equipment is so designed that none of the individual units, when being transported on roads, exceeds a width of 8'3". For transportation in rough, in accessible territory the geared drawworks may be dismantled into five separate, completely enclosed parts, so that loads to be conveyed are exceedingly small.

A further, most remarkable feature is the novel four mast derrick, which can be assembled more easily and rapidly than any old type derrick. This derrick also has been designed to the unit construction principle.

The ingenious design and simple erection of the drilling rig is clearly demonstrated by the fact that a complete rig for a depth of 10,000 ft. has lately been dismantled, conveyed over a distance of 200 miles and re-erected for drilling within the short time of only eleven days. Mention should also be made of the 2,400 hp rotary rig of latest design, which is drilling a well about 17,000 ft deep under the most difficult rock conditions in a German oil field. For the time being, this is the biggest drilling rig employed in Europe.

Figure 4

The oil and the petrochemical industries confront the compressor manufacturing industry with a host of ever new tasks. There are positive displacement compressors, i.e., reciprocating compressors of all types and sizes and rotary sliding vane type compressors, as well as dynamic type axial and centrifugal compressors.

Both stationary and mobile natural gas compressors are required in oil fields. The compressors used are horizontal opposed or angle type and V- or W-type and are characterized by low weights and smooth running. They can be direct coupled with electric motors or gas engines manufactured in series. As the pressure ratio varies in every separate case depending on the original pressure of the inlet gas, the compressors are mostly equipped with interchangeable cylinders.

Compressor stations on pipelines have proved very satisfactory for conveying natural gas over long distances. Rotary compressors are suitable for small volumes of gas, whereas single- or two-casing turbo compressors may be employed for large

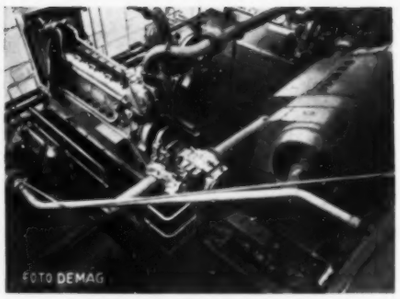


Fig. 2 A view of the machinery equipment.

inlet capacities. If the inlet capacities and pressure ratios involved are both high, the investment costs would be too high if turbo compressors were to be used exclusively. For such cases, compound plants may be employed which are particularly economical, as a turbo compressor is connected in front of a reciprocating compressor.

Figure 5

The design of the turbo compressor as an aerodynamic machine meets frequently made demands that the medium compressed should not be contaminated by any lubricants. However, the prime costs and operating expenses of turbo compressors become economically worth while only if the inlet capacities exceed approx. 3,500 cfm and the pressure ratio is kept within definite limits. For smaller inlet capacities, so-called unlubricated reciprocating compressors are suitable, in which no lubricant is carried into the cylinder, and thus into the medium to be compressed. Horizontal single-frame or horizontal opposed arrangements are preferred in that case, as the valves, piston packings and glands are more easily accessible than in vertical compressors. The piston rod of such compressors has a second guide between the crosshead and the cylinder, so that the usual back guide of the piston rod has become unnecessary. This was in the way when the piston packings, mostly carbon piston rings, had to be exchanged, which was done rather frequently.

Fig. 1 Rotary deep drilling rig.

Fig. 3 Drilling platform with rotary table, power slip and automatic cathead unit.

All photos by Demag.

Fig. 4 Rotary compressors at a gas supply station. Three two-stage compressors, each for approx. 3,500 cfm at a discharge pressure of 85 psig.

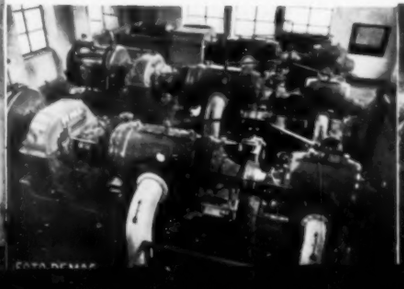
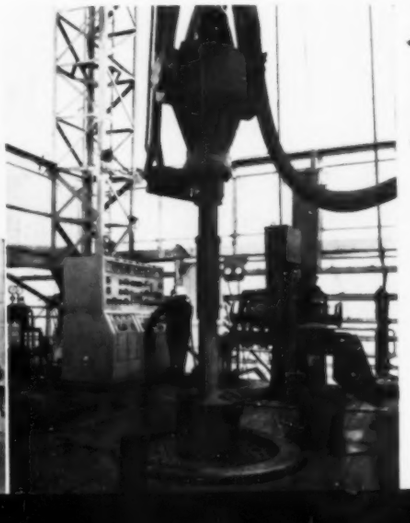


Fig. 5 Two compound plants, each for 17,500 cfm at long-distance gas. Discharge pressure 142 psig.



REICHERT

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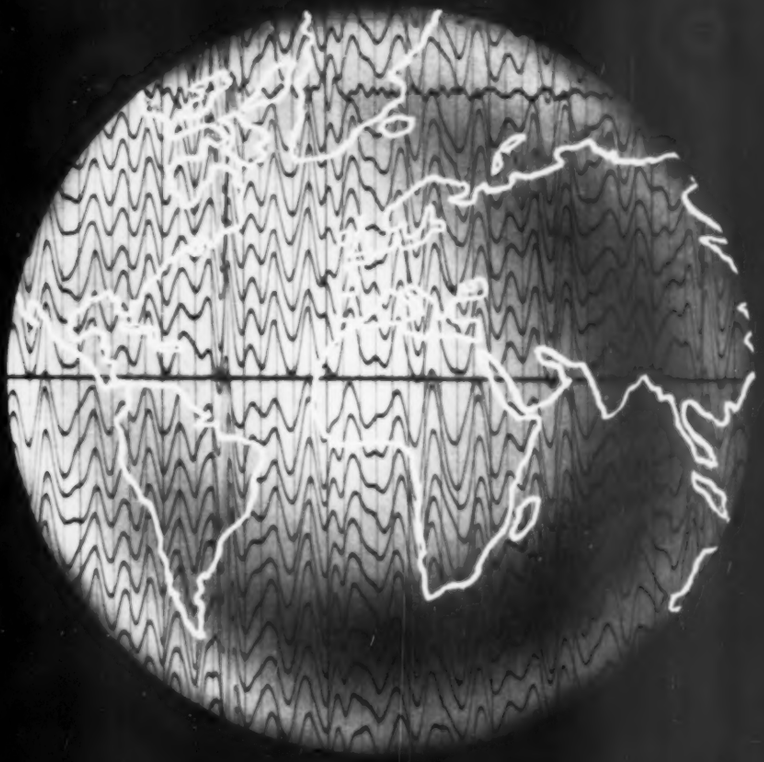

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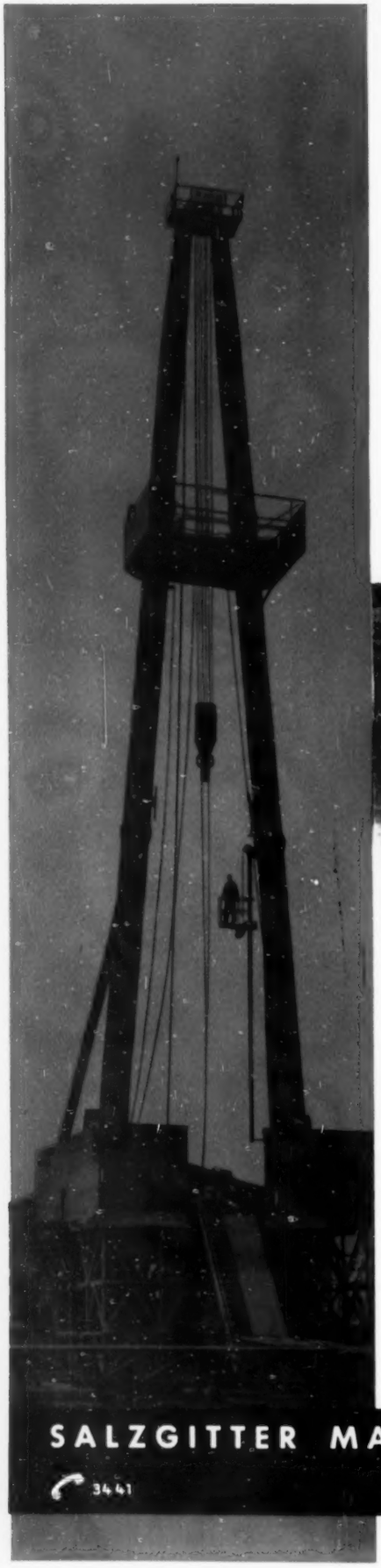

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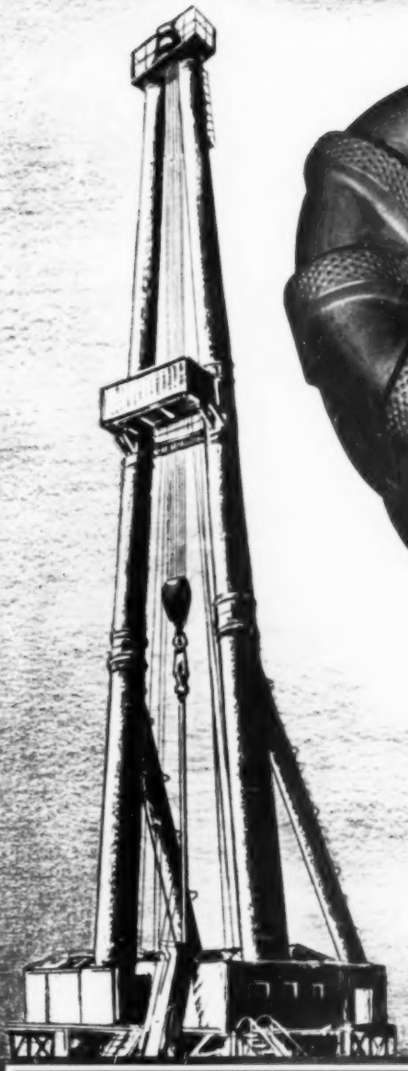

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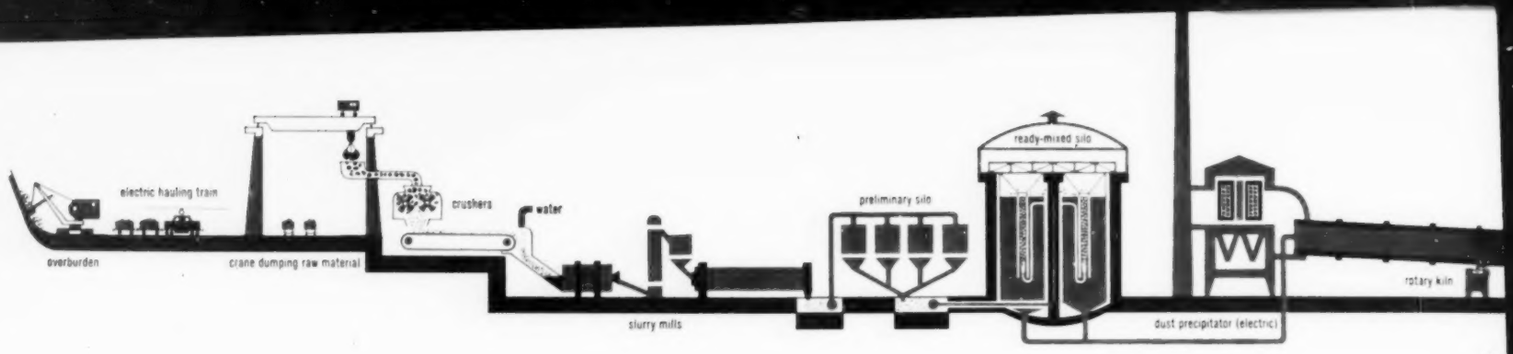


Development of Oil-

Characteristics of portland cement and the advances made by the Dyckerhoff Cement-

The first important characteristic of portland cement was its property of developing into a hard cementitious mass when mixed with water. It was also noted during the early development of portland cement that this property was inherent when cured in air or under water.

With the advent of the drilling of oil wells, major production changes began to take place in the cement used for this application. As the depth of the drilling increased, changes had to be made in the cement and a method of testing instigated to insure a uniform product and to eliminate the production of inferior materials.

Properties such as clinker compositions, thickening time, compressive strength and surface area (fineness) formed the basis for specifications of all cements used in oil wells.

Portland cement is prepared by igniting properly proportioned raw materials of lime, silica, alumina and ferric oxide. The interaction of these materials during the burning process form the compounds present in cement.

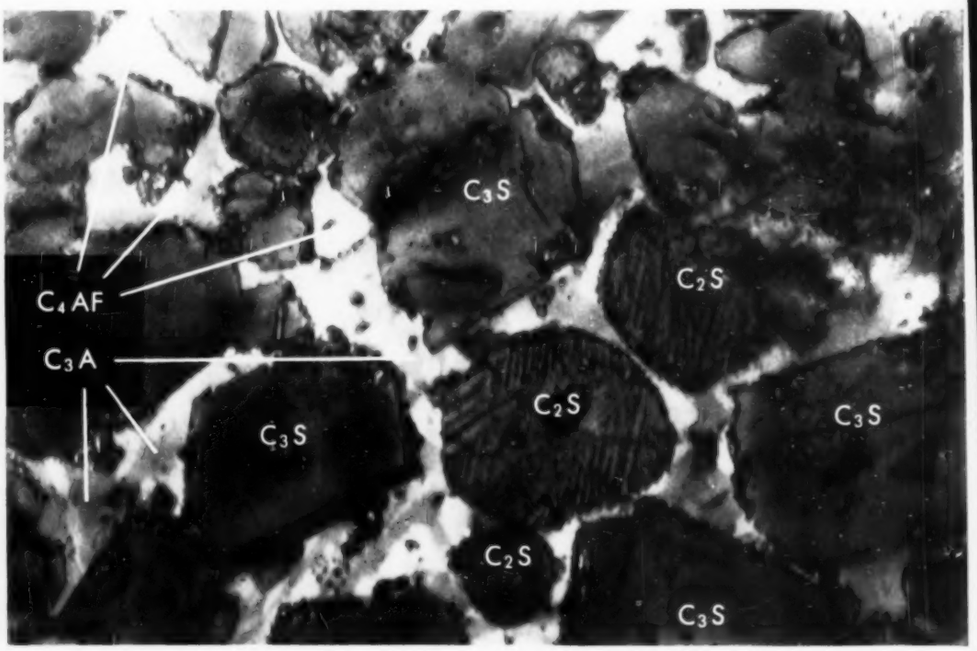
The basic compounds are:

Tricalcium Silicate (C_3S) - Contributes to the early strength of the cement. This stage of strength development is the most important with respect to oil well cementing; for instance, if the tricalcium silicate is increased, a cement with high heat of hydration and high early strength will be produced which corresponds to API Class C Cement (ASTM Type III).

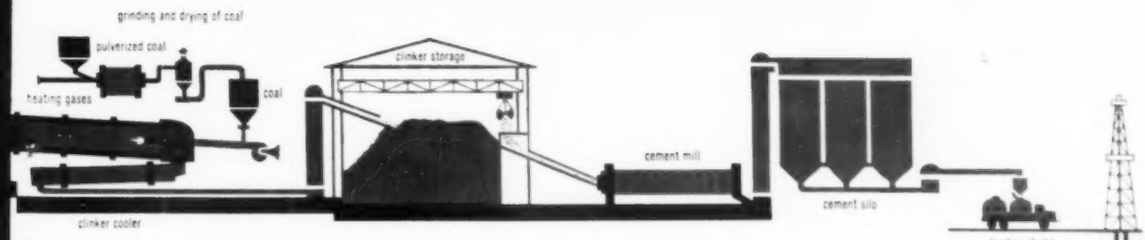
Dicalcium Silicate (C_2S) - This phase hydrates very slowly and, therefore, is the constituent which produces the long term strength increase in portland cement.

Tricalcium Aluminate (C_3A) - interacts readily in water with the evolution of much heat. Its primary contribution to the cementing action is to provide the initial set of the cement. If the tricalcium aluminate content is reduced to less than 5 percent, a type of cement is obtained which has considerably higher resistance to corrosion attack by sulfate waters than an API Class A Cement. More recent scientific investigations have shown, however, that a cement can only be designated as absolutely sulfate-resistant if the C_3A content is zero.

Tetracalcium Aluminoferrite (C_4AF) - Is a low heat of hydration compound in cement, and has very little effect on its properties. The ratio of alumina to ferric oxide determines the relative proportion of the compounds, C_3A and C_4AF. An increase in ferric oxide content or the substitution of ferric oxide for alumina, reduces the proportion of C_3A and increases the C_4AF content in the cement.



Micrograph of Portland clinker ——— 50 μ



Well-Cement

works. Wiesbaden. Germany. to serve the Oil Industry.

The manufacture of cement has taken gigantic strides since the first limestone was calcined and mixed with clay to subsequently become portland cement. From the time of the first-kilns, which had to be emptied after each burning operation and then recharged with new raw materials, to our present day rotary kilns, each capable of producing thousands of barrels of cement annually, chemical and engineering knowledge, plus years of experience, have made it possible to produce uniform clinkers to be ground into cements of the highest quality.

The Dyckerhoff Cement Company instigated a research program on the manufacture of oil well cements at an early date. Associations for quality control of the manufacture of cement were founded in Germany as far back as 1877. Although considerable amounts of cement were imported into Germany during the first half of the last century, Dyckerhoff Cement Company made its first shipment of cement to the United States in 1868. It has always been the endeavour of the company not only to supply the home market with the quality cements but to meet the challenge of problems from other parts of the world.

Recognizing the problems encountered in the field of pure cement chemistry through their manufacture of the various special cements, Dyckerhoff Cement Company sought additional information on the manufacture and use of oil well cements.

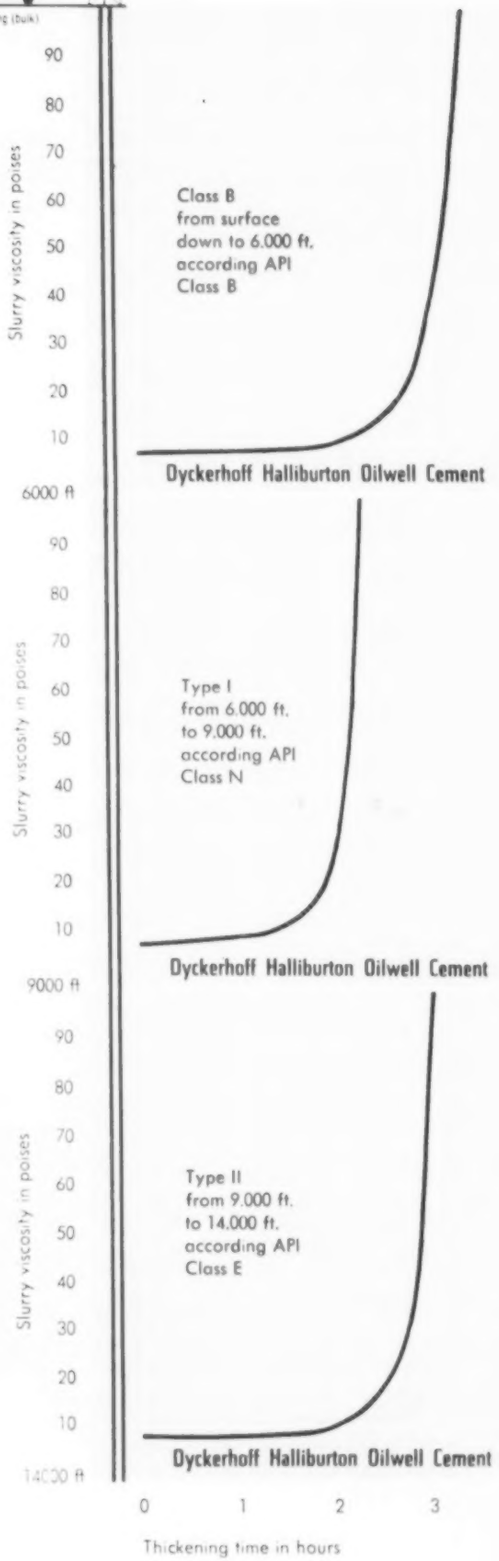
In 1919, our technical staff made a trip to the United States seeking this information. The techniques, skills and knowledge in the use of oil well cements were supplied by Halliburton Oil Well Cementing Company. Halliburton, with over 2.4 million cementing jobs to its credit, has cemented over 338 million feet of pipe equal to more than eight times the circumference of the earth.

From this meeting between the Dyckerhoff Cement Company and Halliburton Oil Well Cementing Company, there has emerged an exchange of ideas on the best materials and methods for serving the oil industry. A result of this meeting is the manufacture of three types of Dyckerhoff-Halliburton Oil Well Cements meeting the American Petroleum Institute specifications for Class B, N, and E Cements. These cements, available throughout South America and in the Eastern Hemisphere, are used in all types of cementing operations, especially, when deep wells are cemented.

New products have been developed and are now available to the industry under the name of Dyckerhoff-Halliburton Oil Well Cement. Pozmix-cement for cementing wells, where light weight slurry and resistance to brine waters are required, is being offered by the Dyckerhoff Cement Company. Another product, Pozmix 140, is an excellent cementing composition for use in wells where extreme temperatures are encountered.

The research program of each company is continually endeavouring to give to the oil industry the best in materials and equipment with which to produce the ultimate in oil well cementing. The research laboratories of both Dyckerhoff and Halliburton are made available to the oil industry to aid in solving cementing problems.

DYCKERHOFF ZEMENTWERKE AG · WIESBADEN · GERMANY



The applications of diamond bits to turbine drilling in Germany

by Hans Joachim Wiemann, technical manager, Ernst Winter & Son, Hamburg.

THE first application of modern drilling turbines in Germany was tried out in the presence of Russian experts in April 1957. Russian built single and multiple section turbines were used. First trials revealed difficulties arising from the unusual geological conditions in Germany.

Following these preliminary tests development work on German drilling turbines was carried out under Russian license through the cooperative work of Salzgitter Maschinen GmbH and Haniel and Lueg. In this research the question of tools received special attention. Diamond bits were used to minimize the wear on roller bits especially in hard strata. These were demonstrated at the industrial fair of Hanover in April 1957.

Fortunately, the German oil industry took a positive stand in the development of turbine drilling, even though considerable money had to be invested to modify drilling equipment, especially slush pumps. In 1957 the German industry drilled about 5,200 meters with a turbine running time of about 1,200 hours. Of these 2,500 meters were horizontal and over 2,600 meters vertical. Of this total depth of 5,200 meters about 5,000 were drilled with roller bits, while diamond bits drilled only 200 meters with a running time of 104 hours.

This picture changed considerably in 1958. The depth drilled exceeded 8,000 meters with a total running time of 3,000 hours. Half of the drilling was horizontal. In 1958 about 5,600 meters were drilled with roller bits and 2,500 meters with diamond bits, a twelvefold increase over 1957.

The application of diamond bits for turbine drilling showed itself especially economical at greater depths by saving expensive round trips. Also turbine running time on bottom with diamond bits, could be raised, because of smoother running of diamond bits and lower stress on turbines caused by excessive bouncing. To achieve the required torsion moment for diamond bits its was necessary to use sectional turbines in all cases for diamond drilling.

In this connection it may be interesting that under ideal conditions of the well equipped testing stand the Salzgitter Maschinen GmbH drilling speeds up to 28 meters per hour in hard diabase were attained.

The development of diamond bits in Germany was achieved by special studies of hydraulic conditions in turbine drilling. It was discovered that special performances of the diamond studded cutting areas and flushing canals permitted reducing the diamond content to half the number used in conventional bits. This made diamond drilling more economical and less risky.

Recently good results were attained with bits employing wing like cutting elements. These forms are a modification of the wing bit tool forms used in rotary drilling before the era of roller-bits.

In this connection it can be said that diamond drilling with turbodrills is developing satisfactorily in spite of difficult geological conditions in Germany. It is hoped to find bit forms, which will allow optimum drilling meterage without tool changing especially in difficult strata. It may be mentioned in this connection, that Russian experts stimulated by visits to Germany and France and against their original scepticism are planning to build special diamond drill turbines which are expected to obtain a maximum moment of torsion at 2000 revolution per minute.

Mobile drilling and servicing rigs

SALZGITTER MASCHINEN AG, one of the oldest companies manufacturing drilling equipment in Germany has achieved, since the war, a considerable amount of development in modern equipment for prospecting for oil, water, and hard rock drilling, amongst which the following features deserve to be discussed:

The SALZGITTER MAST (Gulliver). Its design started from the knowledge that the economy of a drilling rig can be increased essentially by reducing the time required for transport and erection. The Gulliver Mast is available in two sizes with 150 and 300 t hook load. Its characteristic stressed stem or sandwich design brings the constructional weight down to a figure lower than that of comparative masts, and results, besides, in a high torsion resistant stiffness. The most construction is in itself self-supporting, not requiring guy ropes.

Another feature of this full view mast is the system of erection. It does not, like similar masts, require a high substructure to keep erection forces within admissible limits. One can mount it at track level directly at the foot points with only moderate power applied. This simplifies the procedure considerably and saves time. During transport, such accessories, as ladders, slush pipe, lighting, and tong counterweights remain fitted to the inside of the mast.

Mobile Drilling Rigs FB 415 and FB 820: These rigs are built for 6,000 ft, $4\frac{1}{2}$" tubing at 650 hp; and for 9,000', $4\frac{1}{2}$" tubing at 1,100 hp respectively. They are outstanding for the orderly arrangement of the main groups i.e. complete engine unit with drawworks, complete substructure with built-in rotary table and spill, complete Gulliver mast unit.

The complete rig can be assembled in 24 hours or less. It is further noteworthy that the drawworks trailer is suspended in consoles serving at the same time as a counterweight while erecting the mast.

Power transmission is exclusively done via cardan shafts. The rotary table is driven by a hydrostatic-gearing of 250 hp and can be hydraulically regulated. Furthermore, the well known Krupp torque converters with adjustable blades replace friction clutches hitherto used in oil field equipment, and, besides, render superfluous the usual hydraulic brake.

Mobile Servicing Units:

Salzgitter Mobile Servicing Units have seen oil field service for more than 10 years. They set an example for modern light steel construction. All types of mobile winches are self-propelled, and operated by automatic mechanical "Media" switch gears or torque converters, the latter known as so-called TRILOK gears, convertible into hydraulic clutch. This ensures a high efficiency.

The heavy models serve as multi-purpose rigs for servicing jobs up to 3,000 m (10,000 ft.), as completion outfit up to 2,000 m (8,300 ft.), or for drilling jobs to about 1,200 m (4,000 ft.) depth.

Water Well Drilling Rigs:

This is a type PS 150 Drilling Rig in the range which deserves special attention. Since water prospecting involves the application of different drilling methods adapted to the formation encountered, this rig comprises the three known drilling methods viz. percussion, rotary, and reverse circulation drilling. The contractor, therefore, has an extremely economical rig at far less investment cost as compared with three single-purpose rigs, and, moreover, his multiple PS 150 rig makes money all the time.

Rock Drilling Equipment:

A recent development in this field is represented by an easily portable rotary drilling rig with hydraulic power transmission, and, consequently, a wide range of application with standard and diamond bits. Despite its developing a miximum 5-t drilling pressure and maximum 700 m (2,300 ft.) drilling depth, its weight of only 1,300 kg (2,850 lbs.) is outstanding.

Drilling in hard rock, particularly in quarries, is done by an air-operated percussion hammer powered directly at the drilling spot. From a carriage standing on the surface, sensitive adjusting of speed and pressure is rendered possible by hydraulic power transmission.

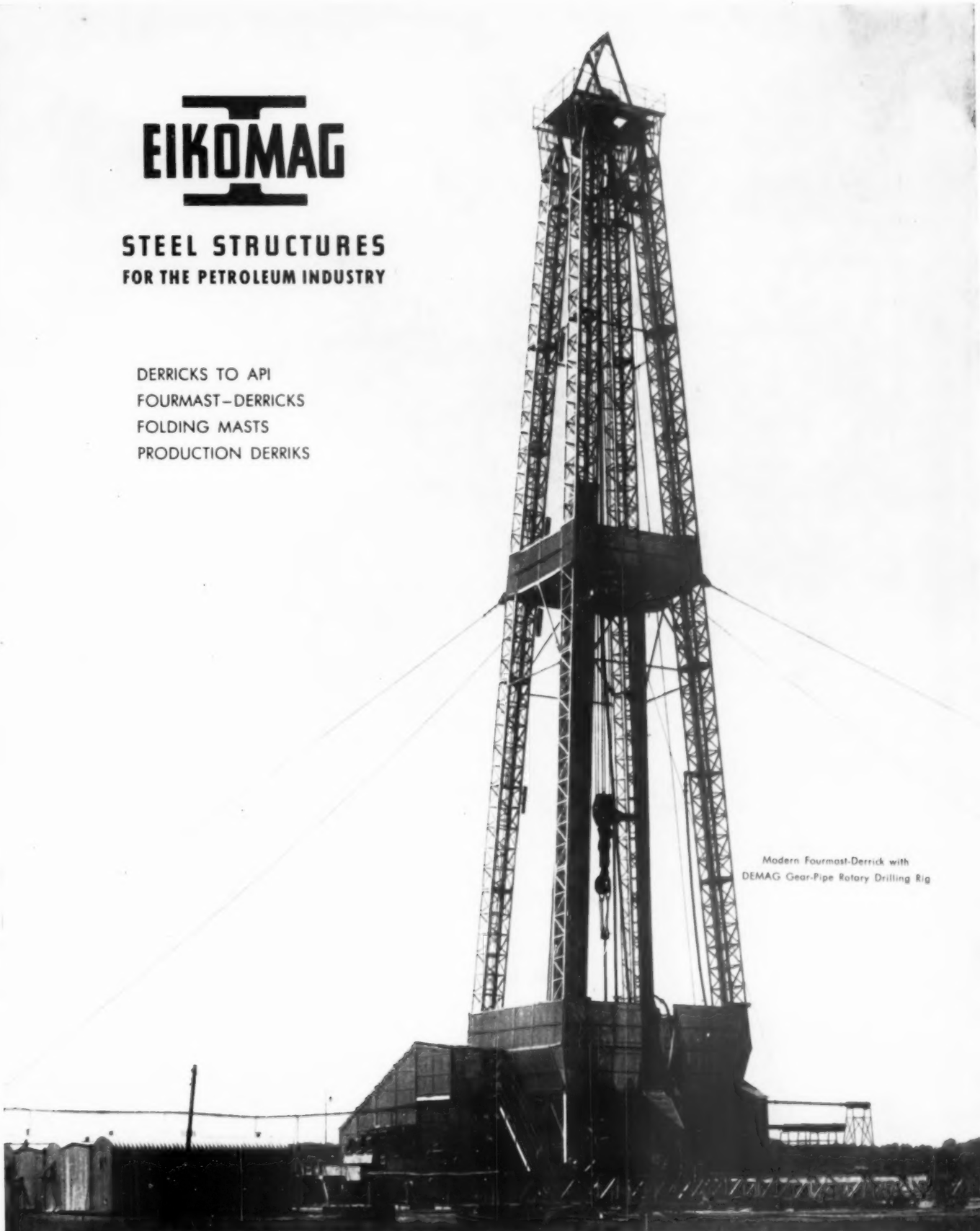
Turbo Drills:

Turbo Drills have been made for two years under a Russian license, in 9", $7\frac{1}{2}$", $6\frac{5}{8}$" and 5" sizes, as single, sectional and core drilling turbines. Geological conditions encountered in Western Europe have brought about several technical and quality changes in a number of components.

EIKOMAG

STEEL STRUCTURES
FOR THE PETROLEUM INDUSTRY

DERRICKS TO API
FOURMAST–DERRICKS
FOLDING MASTS
PRODUCTION DERRIKS



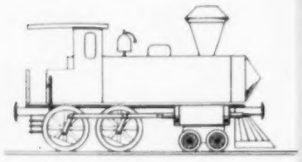
Modern Fourmast-Derrick with
DEMAG Gear-Pipe Rotary Drilling Rig

EISENKONSTRUKTIONEN UND MASCHINENFABRIK GMBH.
DUSSELDORF - WESTERN GERMANY

100 Years ago

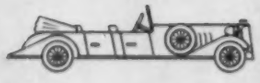
Beginning of Oil Production

40 Years ago



Mintrops Patent
of Seismic Refraction Method

38 Years ago



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first Measurement with
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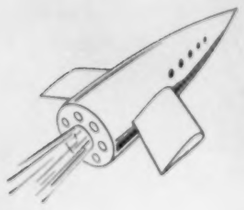

first seismic Fieldwork
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- bewährte seismische Sprengstoffe in verschiedenen Typen und Patronenabmessungen. Starre Kunststoffpatronen mit Schraubverschluß, System „RAPID"
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Our Contribution for Successful Seismic Operation:

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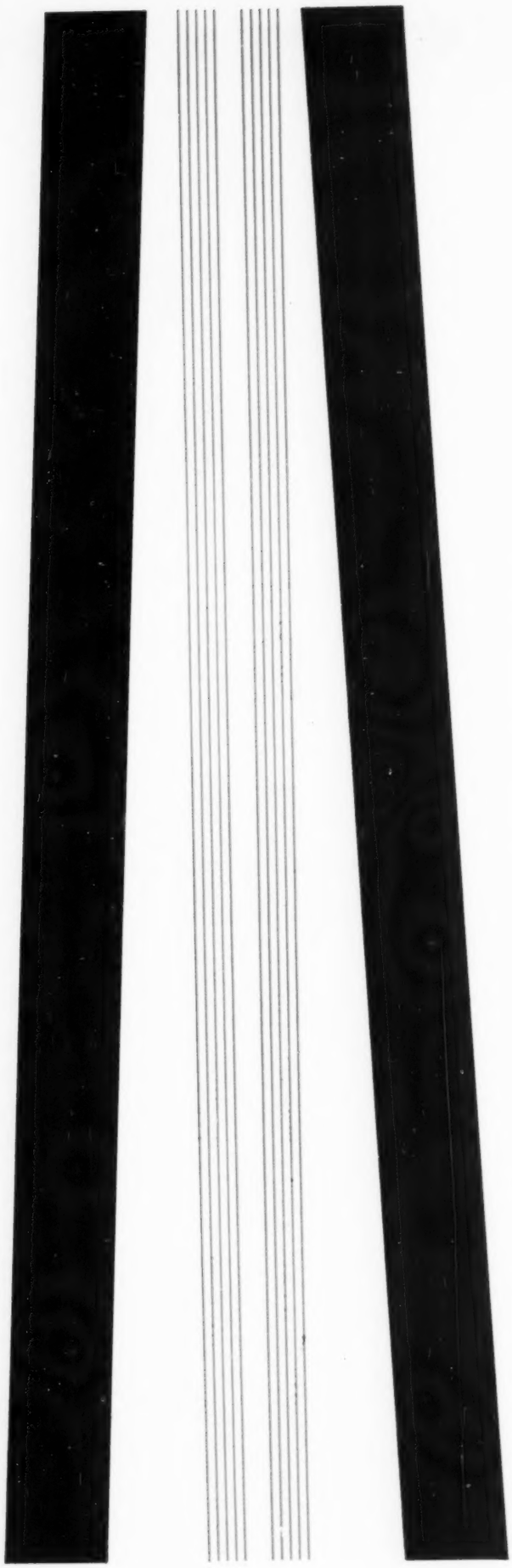
- Détonateurs spéciaux sismiques et perforateurs éprouvés
- Cordeau détonant de divers types

Alfred Nobel

DYNAMIT-ACTIEN-GESELLSCHAFT vorm. Alfred Nobel & Co. Troisdorf bei Köln



DEUTSCHE
SCHACHTBAU- UND
TIEFBOHRGESELLSCHAFT M. B. H.

DRILLING
AND
CRUDE
OIL
EXPLOITATION

LINGEN-EMS GERMANY

High speed diesel engines in the oil field

For a long time the American petroleum industry has been using high speed Diesel engines with revolutions of up to 1,600-1,800 rpm for drilling rigs, and especially industrial motors in the power range of 150 to 180 hp.

Such engines usually are used in pairs coupled with chain drives. The drive can be direct or through a hydraulic arrangement in the power take-off at the drilling rig.

Air operated friction couplings make it possible to actuate or shut off each pair of motors on either of the individual motors; in this operation the following requirements must be met:

1. Greatest operational safety in meeting heavy and variable power demands.
2. Greatest security against wear and other trouble.
3. Economy of weight and space-saving construction in the interest of quick emplacement and change of location.
4. Conformity with mining law and police regulations.

The 6-cylinder and 12-cylinder *Mercedes-Benz* diesel engines Type MB-836 and type MB-820 that Daimler-Benz A.G. has been putting on the market for a number of years have demonstrated their operational safety under stringent conditions, not only in the oil fields but also in transportation by rail or by boat. The low weight of these engines, which is attained by the compact construction and large use of metal fully meets the weight requirement of the modern drilling rig.

The auxiliary equipment of engines used in the oil fields also must meet stringent specifications.

Instead of an electric starter, with which these engines are normally provided, they have a compressed air starter. Fig. 1 shows an oil drilling unit with *Mercedes-Benz* unit MB-836 Bb having an exhaust gas loader. The compressed air starter (Fig. 1 (3) with the same outside measurements as the electric starter, receives the air supply from a compressor through an intermediate pressure tank with an air pressure of 6-8 atm. A turbine rotor in the starting motor is set in motion and its slit engages the gears. Through a safety device care is taken that starting cannot take place unless the motor has been provided with the necessary oil pressure.

To comply with the requirement of the mining authorities that the drilling engines may at any time be stopped by the rig foreman, there is built in a quick-closing clack valve in the air intake line through which the engine is supplied with the necessary fuel for combustion. Also a further condition is fulfilled, in that the engine cannot be started unless the clack valve has been opened. The engine's air supply is purified by passing it through a generously dimensioned oil filter (5).

In view of the fact that drilling rigs are almost always set up in open spaces, provision for warming up the engine is permissible. Years of experience have shown that at the time of starting up, it is especially important that the engine and its whole lubricating system should be brought up to an operating temperature that will correspond approximately to the optimum viscosity of the lubricating oil. An explosion proof electrical preheater, Fig. 2 (4), warms the cooling water and the lubrication oil in ¾ or one hour (depending on the outside temperature) to a temperature of 30 -40° C, which assures ample lubrication of all bearings.

The thermostat in the cooling circuit, Fig. 2 (8), assures that in the warming process the coolant does not at first flow to the radiator itself. It is only when the temperature of the cooling water has exceeded 80°C. that the thermostat opens the circuit through the radiator.

The heat exchanger, Fig. 2 (3), for the motor lubricant and the transmission (5) lies in the cold water circuit.

Between engine, Fig. 1 (2), and transmission (6) is a fluid coupling. The initial velocity of rotation here is n = 1,250 rpm; the limiting velocity of rotation is n = 1,350 rpm for the desired combination. The flange on the transmission provides a seat for the Airflex

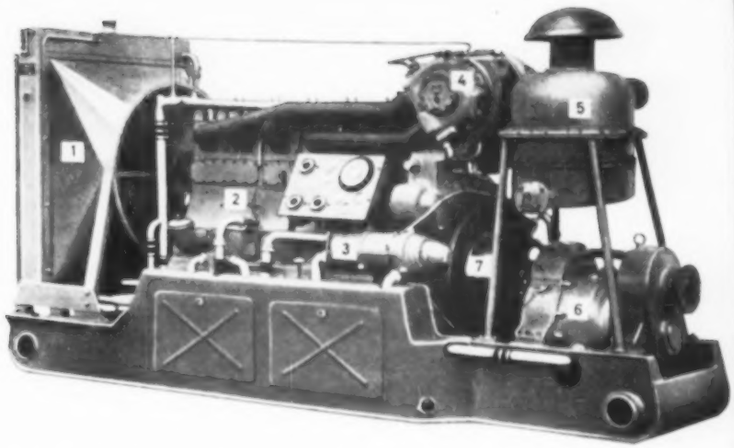


Fig. 1. (No. 78,742) Drive unit for oil drilling motor, capacity 350 hp. (1) Radiator, (2) 6-cylinder Mercedes-Benz MB-836 Bb with exhaust gas loader, (3) Compressed air starting motor, (4) Exhaust gas loader, (5) Oil-bath air filter (6) Transmission, (7) Fluid coupling.

coupling. Through use of the transmission it is possible to simplify the change of drive in operations of lifting and lowering, at the same time the engine is protected from severe shocks.

In the course of development of such plants for the oil fields, provision was made for a still higher engine capacity of power units in the 12-cylinder *Mercedes-Benz* engine M-B-820 Bb, (Fig. 2). In this unit there is a nearly complete automatic control of the starting-up process with simultaneous assurance of the necessary lubrication oil pressure at the very start.

In this plant between the transmission Fig. 2 (5) and the engine (2) a fluid coupling is built in. In the disengaging trasmission (5) the velocity of rotation of the motor is lowered from n = 1,300 rpm to n = 774 rpm within a working rang of 84%, and a corresponding psi value of 0.85. This corresponds to an initial transmission efficiency of 700 hp and an exit transmission delivery of 581 hp. The transmission allows a wide change in cable draft and a corresponding change in cable speed (pxv = constant), so that fewer lifting operations are necessary.

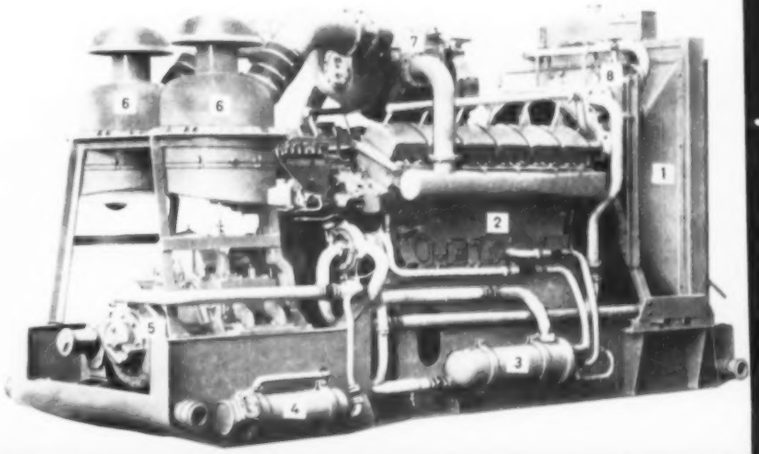
Through the disengaging transmission it is also possible to separate the transmission drive completely from the running motor.

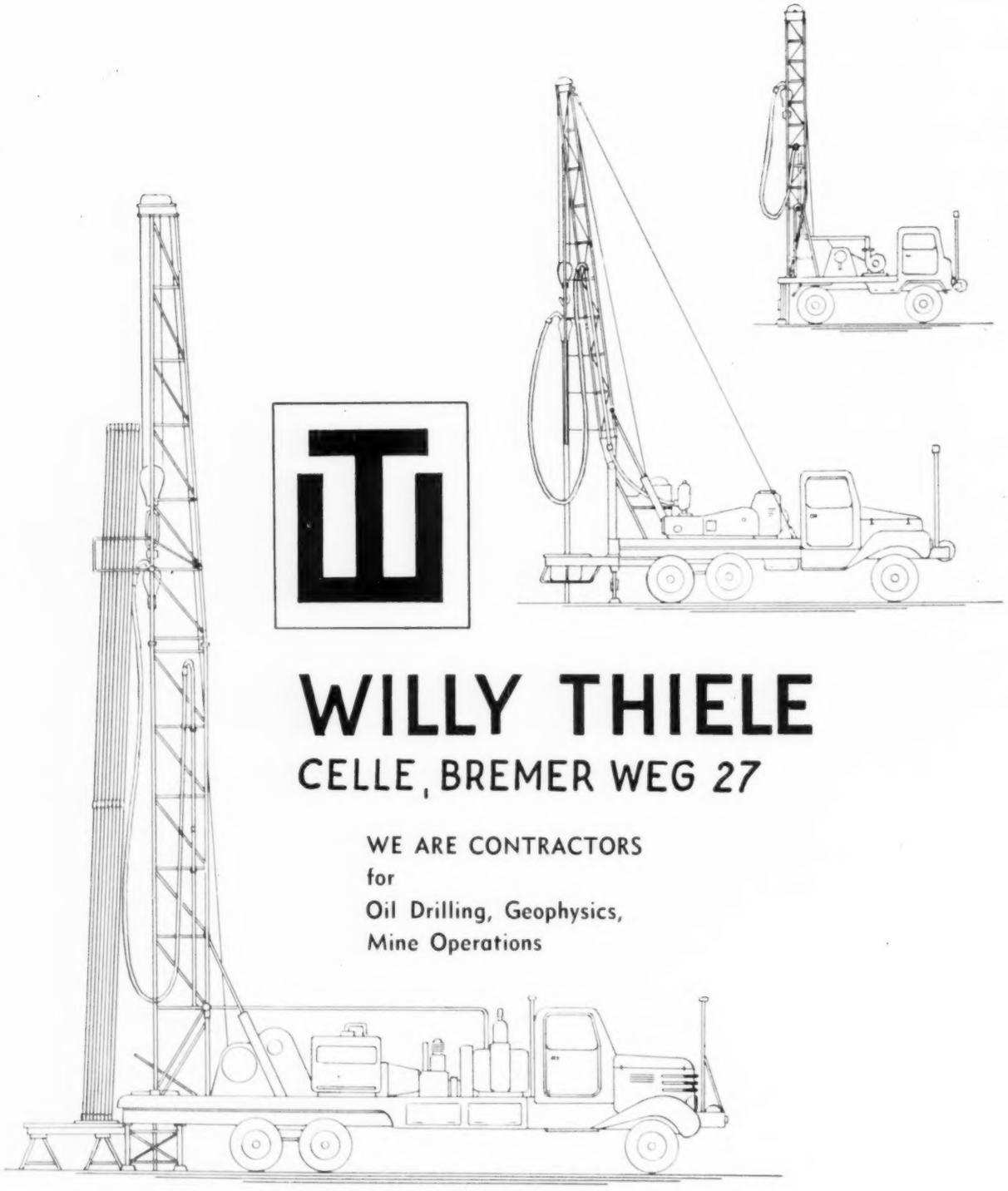
The whole plant, as may be seen from Figs. 1 and 2, is mounted on a skid frame.

A series of plants including both the 6-cylinder Mercedes-Benz diesel engine MB-836 with a capacity of 350 hp at 1,300 rpm, and the 12-cyinder engine with double the capacity—that is, 700 hp at the same rpm have been introduced into the German oil fields and in foreign countries, and have given a good account of themselves under the heaviest loads.

With these newly developed drive units, the oil drilling industry now has at its disposal a set of modern engines in which have been incorporated the progress made in diesel engine developments that have been made during the last 10 years, with special reference to lightness of weight and the smallest possible dimensions and with assurance of an absolute operational safety; for these reasons they have attracted widespread consideration.

Fig. 2. (No. 78,743) Drive unit for oil drilling motor, capacity 700 hp. (1) Radiator, (2) 12-cylinder Mercedes-Benz Diesel engine M.B.820 Bb, with exhaust gas loader, (3) Heat exchanger for motor oil and transmission oil, (4) Electric preheater, (5) Transmission, (6) Double oil-bath air filter, (7) Exhaust gas loader, (8) Thermostat.





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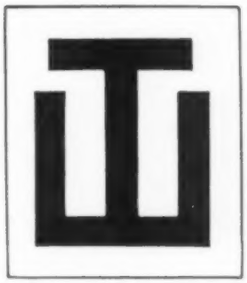

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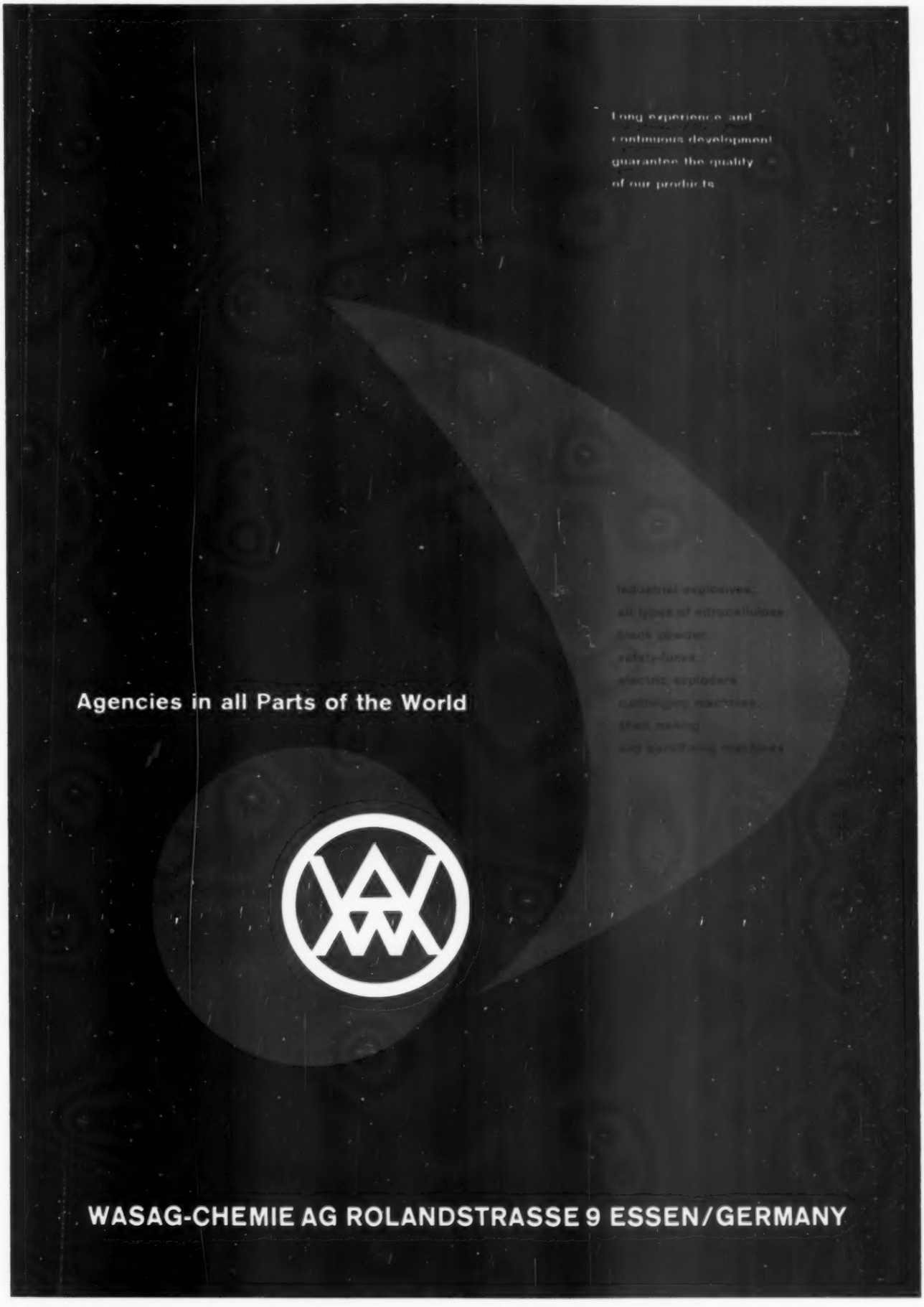
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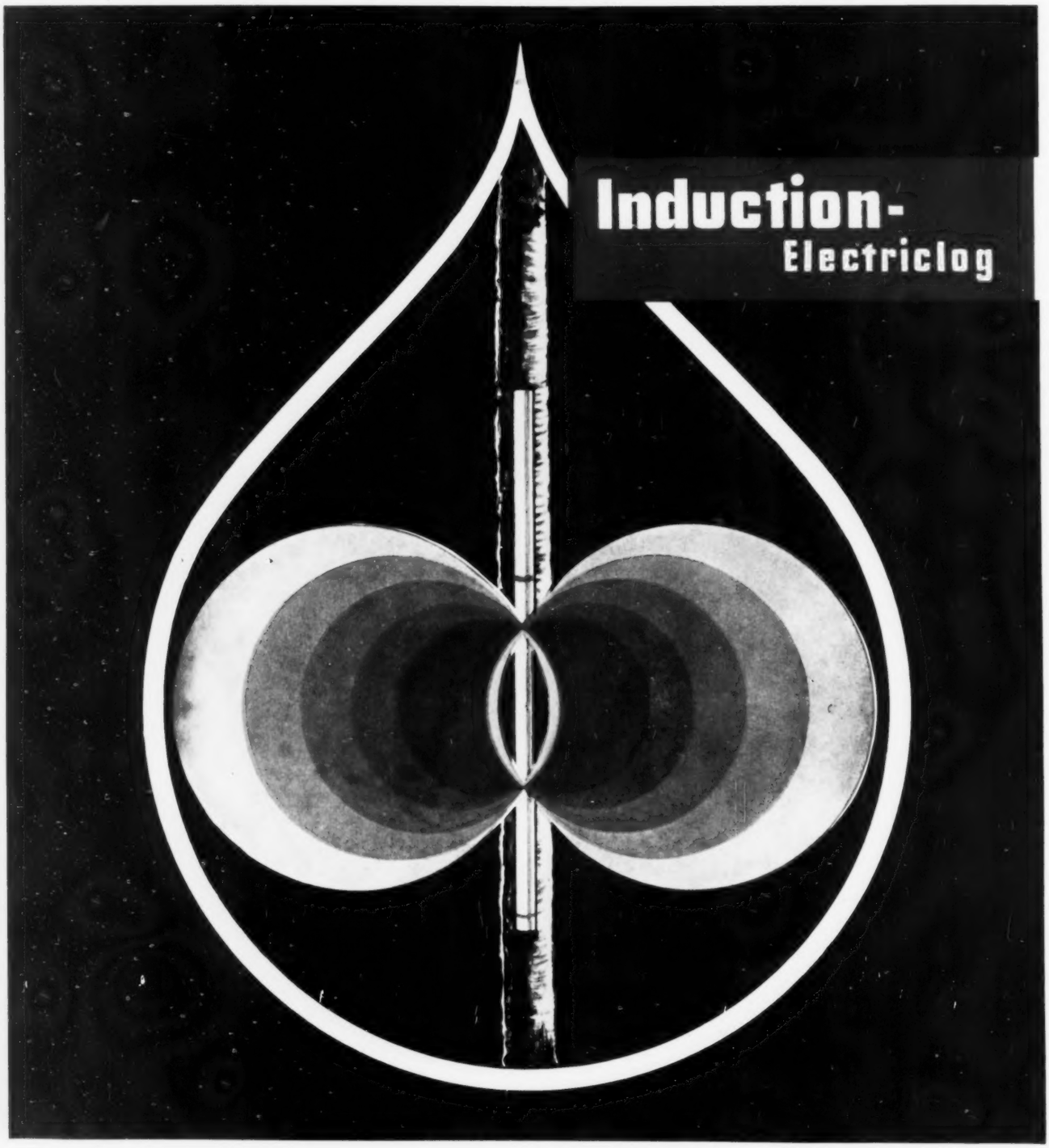

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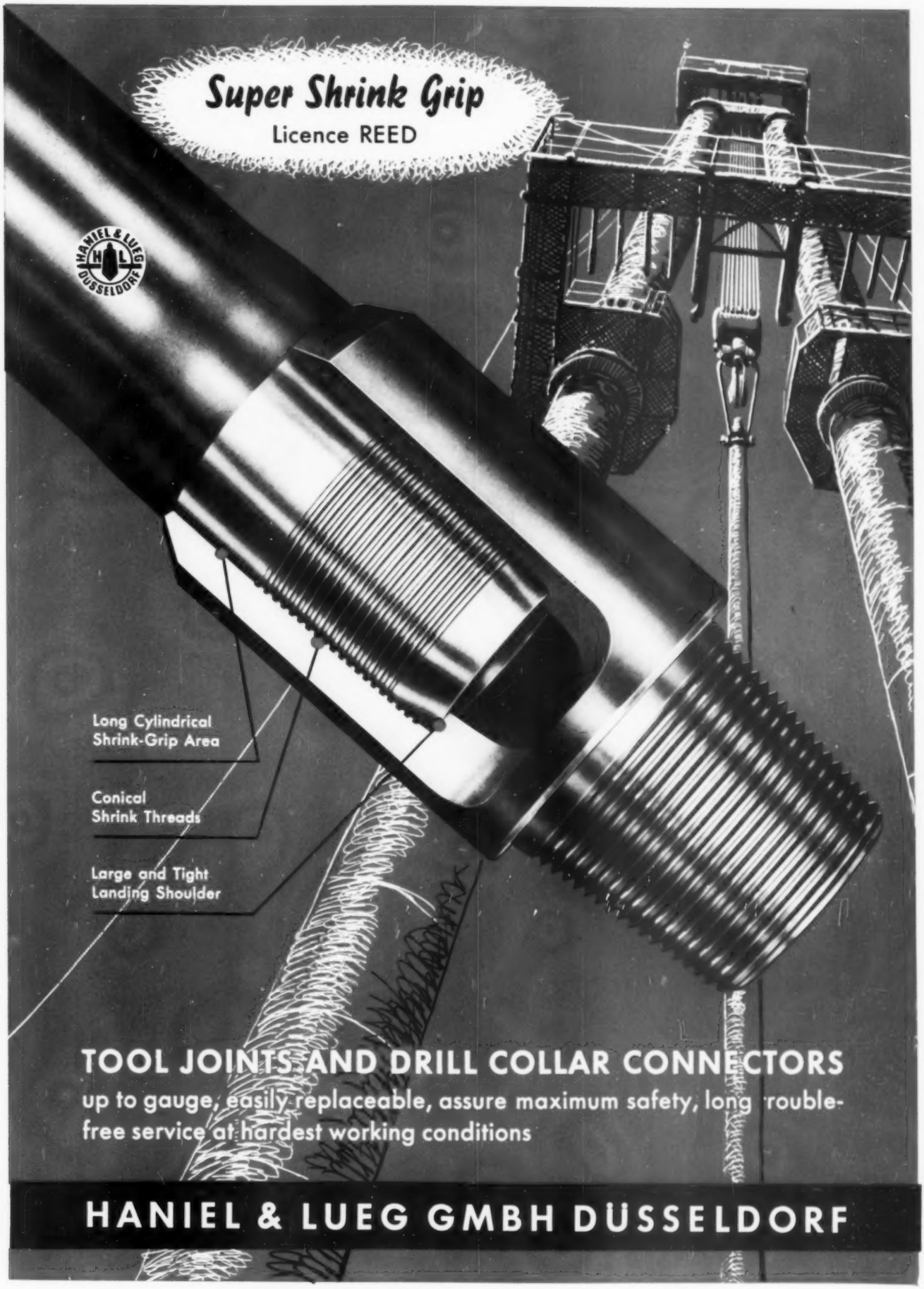
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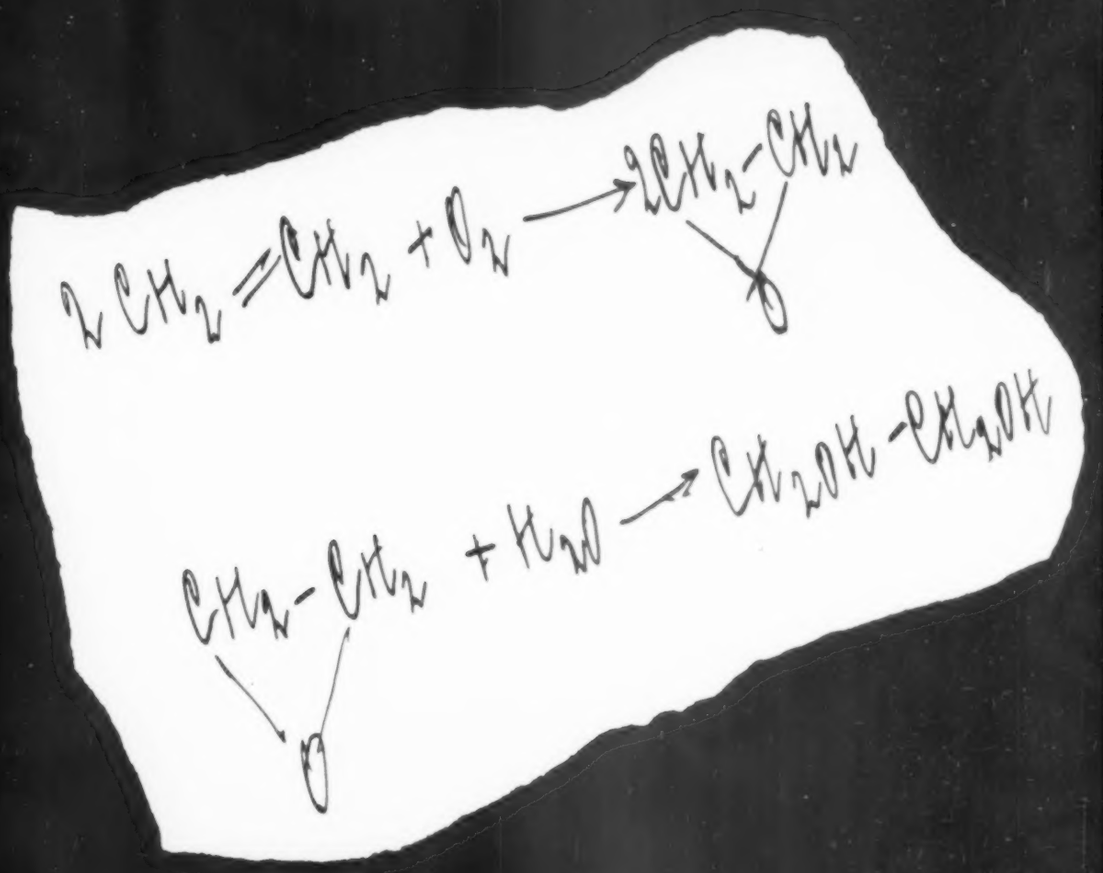
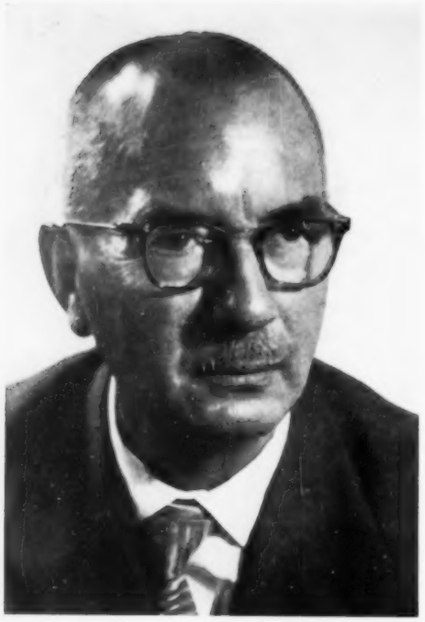

2 CH2=CH2 + O2 → 2CH2-CH2
O
CH2-CH2 + H2O → CH2OH-CH2OH
O



The Max Planck Institute for Coal Research in the Service of International Science (and Economy)

by Prof. Dr. Karl Ziegler, Director of the Max Planck Institute for Coal Research

THE Max Planck (up to 1947 The Kaiser Wilhelm) Institute for Coal Research, like all the 40 research institutes of the Max Planck Society, is remarkable for a particular form of organization likely to be unique in the world; for the selection of research themes and the manner of their treatment, only the Director of the Institute is responsible. Thus far he is in no way subject to any directives from the Max Planck Society itself, from the Government, or from the industrial organizations that help to finance the Institute.

This principle and the strictness of its realization excites the wonder of the numerous visitors from all parts of the world, who can hardly undertsand that the old adage that "he who puts up the cash will have a say" does not apply here. It is self-evident that such a basic idea puts the freedom of science in an extremely favorable position to shape up its own course. It is also clear, however, that the results will depend in a high degree on the choice of the personalities who are to head the institutes. This principle was established at the foundation of the Kaiser Wilhelm Society in 1911, and this action was expressed in the concept that, so to speak, the individual institute will be "built around the director." Such a concept can, of course, only be applied purely when an institute is founded. In the selection of any succeeding director the question would arise how the existing scientific tradition and the general line expressed in the name the institute carries may best be adapted to the ideas and special capabilities of the new man. It would easily turn out—and the development of the Institute at Muelheim is proof of it—that the new objectives of the instiute and the success of its work might not coincide with what is supposed to be the original purpose.

At the foundation of the Muelheim Institute in 1912, coal was indeed the central point in the Institute's activities. The first director, Franz FISCHER, in his service of about 30 years, carried out a series of very important researches that contributed much to the knowledge of coal, which was put to use in many ways by the German coal mining industry. However, apart from the special case of the FISCHER-TROPSCH synthesis which will be mentioned further on, much of the benefit industrial coal practice experienced from the Institute's work was an indirect one, arising from the general increase in the knowledge of the physical properties of coal as well as from better test and analysis methods. Numerous impulses, often not in a visible shape, were subsequently reflected in the practices of the industries concerned with coal.

Scientific knowledge is not restricted by national boundaries. And so it came about that what was within reach of the German coal industry became available to coal-working industries throughout the world. Frequently those using new practices and research methods in modern laboratories for the study of coal are not aware of the fact that much of their everyday know-how is based on the work of Franz FISCHER and his coworkers at Muelheim.

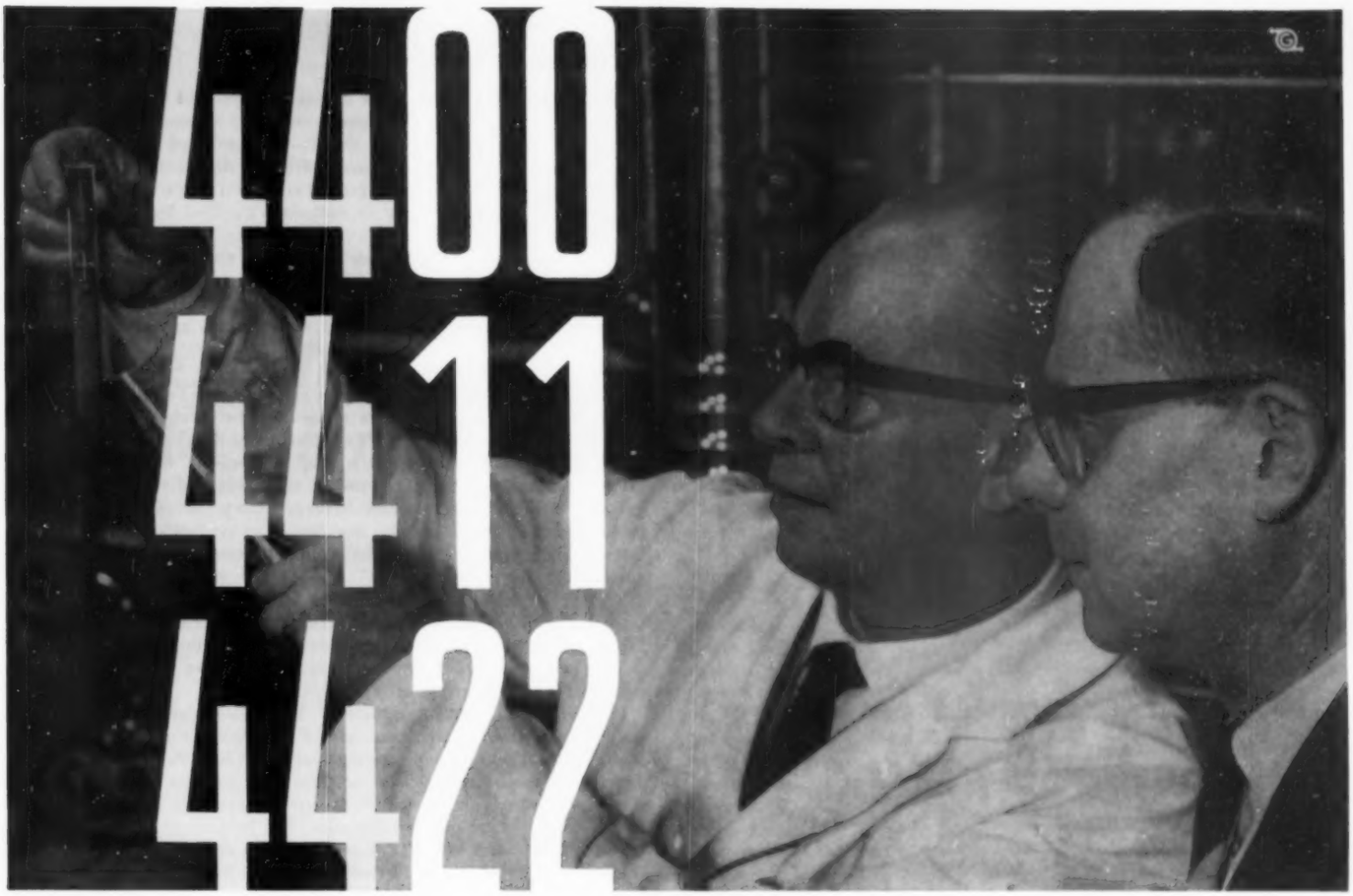
Very well known to every technologist, however, is the gasoline synthesis of FISCHER and TROPSCH as a great achievement of the Institute at Muelheim and its first director, Franz FISCHER. Their work in 1925 was undoubtedly their first step in the transition from pure coal research to research on the compounds of carbon, that means to synthetic organic chemistry.

The Fischer-Tropsch synthesis was one of the broad-based investigations in which coal was subjected to chemical transformation and refinement. In this connection it should be remembered that in the year when the Institute was founded there was no real chemistry of coal, and what was then known and was of some industrial importance at all amounted to a chemistry of tar. The synthesis itself was an organic-chemistry process. Its discovery and development had the consequence that the core of the Institute's work became more and more pure chemistry.

There is a certain tragic element in the fact that this process discovered and developed in Germany has no more economic chance in the land of its origin. Aside from two small companies in West Germany which are devoted to certain special products, and aside from a plant in the Russian-occupied part of Germany, where economic considerations are superseded by autarchical dogmas which forbid comparison to western conditions, there are no Fischer-Tropsch plants in western Europe. On the other hand, in South Africa the SASOL (South African Coal, Oil and Gas Corporation Ltd.) in Sasolburg runs a large new Fischer-Tropsch plant which operates on an easily accessible deposit of a very cheap coal and is a fine example of how the influences from the Institute's work on industrial Chemistry are alive far beyond Germany's borders.

It is also known that in the American petroleum industry during the last war and for a time immediately thereafter there was great interest in the Fischer-Tropsch synthesis, and many good studies were carried out in this field; and though this work did not materialize in the erection of large plants, this is due only to the fact that the time is not yet ripe for it. So long as enough oil is available the problem of liquefying coal, which has already been solved, will for economic reasons hardly have a chance of being established on a large scale.

The succeeding director of the Institute, who was installed in 1943, is an out-and-out organic chemist. When accepting the call to Muelheim he stipulated full freedom of investigation throughout the entire field of organic chemistry. His work in the field of organometallic compounds seemed to indicate no connection with the original purpose of the Institute. But it soon became evident that a series of hitherto little heeded organometallic compounds were very active in the catalytic transformation of a great number of olefins, and in the period between 1948 and 1958 this led to the rather rapid development of a new division within organic chemistry. Now olefins are



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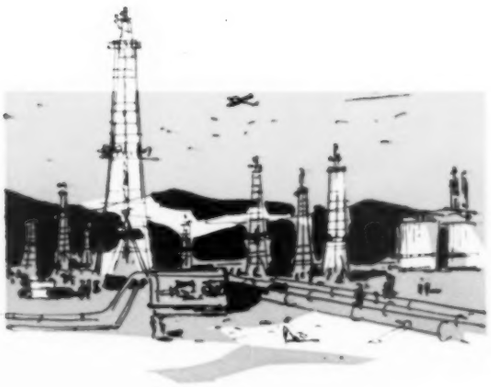

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obtainable through the thermal treatment of coal as well as through the refining of petroleum, and therefore this new research work from the Institute also fostered the process of coordination of interests between petroleum chemistry and coal chemistry; precisely in the field of olefin transformation the interests of both are identical.

This entire modern development is a very nice example of the mutual stimulation of scientific research in quite different countries of the world. A decisive starting point of the new research was first a purely scientific study of the reaction between ethylene and lithium-aluminum-hydride. The lithium-aluminm-hydride was a highly important discovery of the American chemist SCHLESINGER and his associates. The new chemistry of ethylene and other olefins has now been thoroughly opened up in Germany, but now it has an even greater importance for the American industry. This comes from the fact that petroleum refining in the U.S.A. has an extremely great extent and therefore makes great quantities of olefins available. In addition the French, the British, the Italians and the Japanese paid attention to the Muelheim work. The number of chemists in the world who today are working in the field of "Muelheim chemistry" far outnumbers the Muelheim staff, which ten years ago had about twenty chemists and today about forty.

An event that set off an almost explosive expansion of scientific and economic-technical activity in the new field throughout the world was the discovery of the Organo-metallic Complex Catalysts in the Muelheim Institute in 1935, which allows making low-pressure polyethylenes, isotactic polypropylenes, poly-cis-1,4-isoprene (synthetic natural rubber), cyclododecatrienes from butadiene, and many others. These products are here mentioned in the order of their discovery. They were all prepared with Muelheilm catalysts. The countries in which they were discovered were, however, in this order: Germany, Italy, U.S.A., and again Germany. When not long ago a well-known American journal reported that to date in the field of polyolefins some 40,000 U.S. patent applications had been filed, which required the appointment of 250 additional examiners in the Patent Office, the author cannot guarantee the accuracy of these figures, but even if the figures were considerably smaller they would still be very impressive.

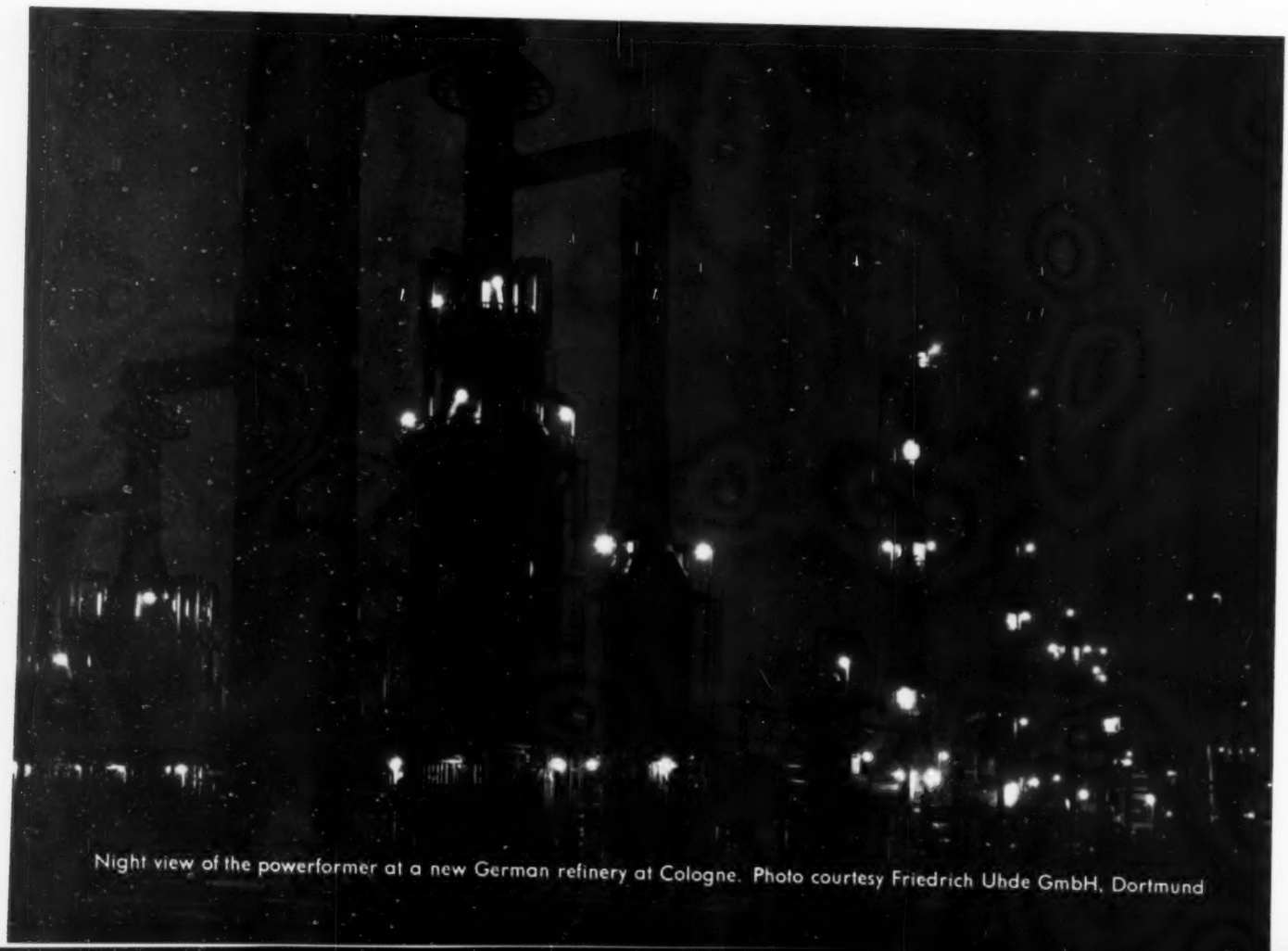
It may be that many of these inventions were not inspired by the work at Muelheim, since, as often happens in science, in a kind of duplication of events some of the above-mentioned problems will be simultaneously dealt with and solved in different ways and in different surroundings. At any rate, it is certain that a high percentage must have been directly or indirectly inspired by the work at Muelheim.

Another small example: when in 1956 the author was invited by Russian colleagues to visit Moscow and Leningrad he saw three institutes which were working toward closely related goals, namely, macro-molecular chemistry, plastic masses, and synthetic rubber. In each institute large research teams were studying the Muehleim complex catalysts.

The reference of the aforesaid was only to those fields of research where the world-wide influence of the Muelheim work has become very clearly visible. On a smaller scale there is a series of similar Muelheim results. Brief mention may be made of the preparation of carbonic acids from olefins, carbon monoxide and water; investigation of boron alkyls and boron hydrides; the preparation of various organo-metallic compounds by new methods; synthesis of the higher fatty alcohols and other long-chain aliphatic compounds from ethylene.

The whole history of the Muelheim Institute has clearly shown that wherever the spirit of pure scientific research prevails it will rebound to the benefit of international science and economy, even though at the beginning consideration may be given to the local national science and economy.

Moreover this Institute's history has again demonstrated the soundness of the research principle of the Max Planck Society: for it can be said with reasonable certainty that had its director been dependent upon the criticisms of dissenting patrons his particular work would have succumbed in its very beginnings which seemed so far from any practical usefulness. The leading principle of the Max Planck Society, which was set out at the beginning of this article, seems to me, as far as I know, realized to full extent only in the homeland of the Society and thus to be a specific German contribution to the progress of science.



Night view of the powerformer at a new German refinery at Cologne. Photo courtesy Friedrich Uhde GmbH, Dortmund

More refineries on the Rhine

Isopropanol plant at Farbwerke Hoechst. Photo courtesy Friedrich Uhde GmbH, Dortmund.

by A. M. Stahmer

WHILE the general upward trend of the West German economy has somewhat slackened during the past year, the consumption of mineral-oil products continued to grow according to forecasts. Fuel oil was offered on the German market at low prices; and this, in addition to technical advances, was an impetus for industries and households to switch from burning coal to using this modern energy source. Motorization made further progress, and thus a higher demand of motor gasoline and diesel oil had to be met. The large-scale road-building program of the federal republic requires more asphalt.

If political conditions connected with the situation in Berlin cause no unforeseen crises, there is little doubt that in years to come the energy needs, and especially the demand for oil products, will increase in West Germany more and more. It is only natural, therefore, that the petroleum industry is at work on plans for increasing major refining capacities.

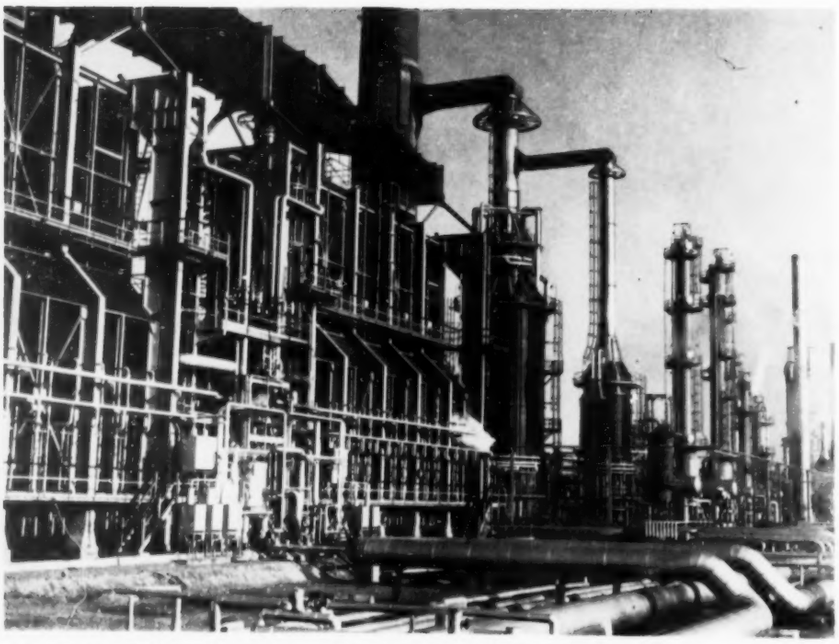
The postwar refinery expansion program started at Hamburg, Germany's normal peacetime import harbor, which is capable of further increased transport of finished oil products. Hamburg, however, was cut off from its hinterland by the Iron Curtain; and, with hopes of an early reunification of the country fading, the oil companies decided to place most of the additional needed refining capacity close to the Ruhr area, the main oil-consumption center of the federal republic. Existing plants in the area, viz., the big hydrogenation works—which were converted after the war from coal liquefication to crude-oil processing—considerably enlarged their potential; and during the past three years the building of four major refineries on or near the Lower Rhine has been under way. One of them, Esso at Cologne, started early in 1959.

If Hamburg, together with Bremen and the processing plant at Heide (Holstein)—linked by pipeline with the Kiel Canal—can be regarded as a separate refining district, the Lower Rhine-Ruhr area will be a second crude-processing center, the importance of which is already increasing steadily. Furthermore, some refineries have existed for some time or were erected since the war near the indigenous oil fields in the province of Lower Saxony. A fourth refining center may, however, be erected on the Upper Rhine near Karlsruhe town—not far from Strasbourg, the terminal of the planned crude-oil pipeline from Marseille to the Upper Rhine. Refineries in or near Karlsruhe would greatly improve the supply situation in the southern part of the country. Up to now only two small plants have been situated in southern Germany, and they are currently shut down.

The refinery location trend is already obvious compared with the situation at the beginning of 1955. At that time, the North Sea harbors (mainly Hamburg) claimed first place, with 48% of the total refining capacity of West Germany. The Rhine-Ruhr district followed as second, with 40.1%; Lower Saxony was third, with 11.5%. The remaining 0.4% fell to southern Germany. On January 1, 1959, distribution of total refining capacity was as follows: Rhine-Ruhr district, 52.4%; North Sea harbors, 39.5%; Lower Saxony, 7.9%; and southern Germany, 0.2%. Thus, more than one-half of the German crude-processing potential has already been concentrated in the west at Gelsenkirchen, Cologne, and other areas of the Rhine-Ruhr district. In future, their share will increase further—probably reaching two-thirds by 1961.

West Germany is now experiencing its second postwar expansion period in petroleum refining. In the first period, completed four years ago, modern cracking plants, together with new distillation units, were built to meet the rapidly growing demand for motor fuels. The main target now is to build high-efficiency fuel-oil producing plants. After the first period, total crude intake capacity stagnated or increased but slightly after 1955. In 1958, a 62.8% increase to 27 million tons annually (about 540,000 b/d) marked the beginning of the second postwar expansion period.

Table I shows the crude-input capacity of the various refineries at the end of 1957 and at the end of 1958. The bulk of the 1957 increase was in five works, viz., Esso, at Cologne; Deutsche Shell, at Hamburg-Harburg, and the three hydrogenation works of Gelsenberg Benzin at Gelsenkirchen; Scholven-Chemie, at Gelsenkirchen-Buer; and Union Rheinische, at Wesseling.



Esso refinery at Cologne showing heaters, Powerformers, and Hydrofiner.

Table I

Annual Crude Capacity of West German Refineries

Company	Plant Location	Crude Capacity (Thousands of Tons) Dec. 31, 1957	Dec. 31, 1958
Badische Anilin- und Sodafabrik AG	Ludwigshafen [1]	48	48
BP Benzin und Petroleum AG (British Petroleum Co. Ltd.)	Hamburg-Finkenwerder	1,900	2,000
	Dinslaken [2]	—	—
Deutsche Erdoel AG	Heide	810	1,500
	Wietze	40	40
Deutsche Shell AG	Hamburg-Harburg	900	2,800
	Monheim	260	260
	Godorf [3]	—	—
Esso AG	Hamburg-Harburg	2,520	2,540
	Cologne	—	3,400
Gelsenberg Benzin AG	Gelsenkirchen	3,300	4,500
Gewerkschaft Deurag-Nerag	Misburg near Hannover	800	900
Gewerkschaft Erdoel-Raffinerie Emsland	Lingen in Emsland	800	1,000
Gewerkschaft Greiff Bergbau	Dollbergen	24	—
Kraftstoff-Handelsgesellschaft mbH	Essen	80	121
Mineraloel- und Asphaltwerke AG (Mawag)	Ostermoor on Kiel Canal	150	180
Mineraloelwerke Peine (Schindler)	Peine (Hanover)	18	18
Mineraloelwerke Albert Sengewald	Dedenhausen	42	42
Mobil Oil AG in Deutschland	Bremen-Oslebshausen	770	1,500
Oelwerke Julius Schindler GmbH (BP)	Hamburg-Neuhof	220	220
Purfina Mineraloelraffinerie AG	Duisburg [4]	—	—
Ruhrbau Mineraloelraffinerie GmbH	Muelheim on Ruhr	300	300
Ruhrchemie AG	Oberhausen-Holten	375	400
Ruhroel, Chemiewerk der Steinkohlenbergwerke Mathias Stinnes AG	Bottrop	120	120
Scholven-Chemie AG	Gelsenkirchen-Buer	1,000	2,000
Union Rheinische Braunkohlen Kraftstoff AG	Wesseling near Cologne	2,000	3,000
Wintershall AG	Salzbergen in Emsland	105	115
Zeller & Gmelin	Eislingen in Wuerttemberg	8	8
		16,590	27,012

[1] Shut down.
[2] BP is building a 4-million-ton refinery.
[3] Shell is building a 4-million-ton refinery.
[4] Purfina is building a 1-million-ton refinery.

Table II

West Germany's Refinery Output of Finished Products (Tons)

	1957		1958	
LP Gas	366,050		434,937	
Motor gasoline	3,148,676		3,711,904	
SBP spirit	166,124	3,680,850	169,400	4,316,241
Kerosine	39,689		41,928	
Power kerosine	1,411		677	
Jet fuel	60,944	102,044	152,928	195,533
Diesel oil		3,176,877		3,792,277
Lubricating oil		369,191		396,718
Fuel oil		2,720,637		4,349,741
Bitumen		745,733		891,259
Other products		754,878		854,436
		11,550,210		14,796,205

With completion of the first building stage, Esso (Cologne) has an annual crude-input capacity of 3.4 million tons (about 70,000 b/d). The refinery is equipped with a Powerformer for the catalytic reforming of topped gasoline (capacity 350,000 tons); two Hydrofiners for desulfurizing gas oil and jet fuel (650,000 tons); and a steam-cracker for production of petrochemical raw material (200,000 tons). On October 15, 1958, the first 1,500 tons of Venezuelan crude (Tia Juana light) arrived at the new oil harbor of Cologne-Niehl by a river tanker from Rotterdam. In November, test runs of the atmospheric distillation unit were started. Then in January, after the refinery had received the first cargo through the recently completed Wilhemshaven pipeline, further refinery units were placed on-stream.

After completion of the Hohe Schaar section in the autumn of 1958, the combined Shell refinery at Hamburg-Harburg (situated on both banks of the south Elbe River) had a total annual capacity of 2.8 million tons (about 56,000 b/d), i.e., 1.9 million tons (about 38,000 b/d) more than one year before. While lubricating-oil units and an asphalt plant were already available in the older section of the refinery, the newly built part of Hohe Schaar comprises, among others, a catalytic cracker with an annual capacity of 550,000 tons; two UOP Platformers with a combined throughput of 350,000 tons annually; and a BPM-Trickle hydrosulfurizer for the desulfurization of gas oil, with annual capacity of 350,000 tons. The total Hamburg-Harburg refinery of Deutsche Shell AG is to produce about 25% of carburetor fuel, 30% diesel oil; 3% lubricating oil; 27% fuel oil; 10% of asphalt, with 5% other products and the refinery's own consumption.

The hydrogenation works of Gelsenberg Benzin AG, at Gelsenkirchen-Horst, at the end of 1958 placed in operation a new distillation unit, increasing total annual crude capacity to 4.5 million tons (about 90,000 b/d)—1.2 million tons more than at the end of 1957. Gelsenberg Benzin is now top-ranking in West Germany. In 1957, Gelsenberg Benzin's share of total German refining amounted to 40.5% (on Middle East crudes). Crudes from Texas and Venezuela accounted for 59.5%. Output in 1957 was 736,000 tons of gasoline; 643,000 diesel oil; 146,000 light fuel oil; 281,000 heavy fuel oil; and 94,000 tons of LPGas. Motor fuels recovered at Gelsenberg are mainly distributed by BV-Aral AG, and the fuel oil by Raab Karcher GmbH. Some crude is refined at Gelsenberg under contract for Esso and Caltex.

The hydrogenation works of Scholven-Chemie AG, at Gelsenkirchen-Buer, which is also a supplier to BV-Aral AG, doubled annual crude capacity in 1958, and now amounts to two million tons (about 40,000 b/d). In 1957, 690,000 tons of crude were processed by Scholven-Chemie AG, including 61% crude of German origin. Output was 572,000 tons of motor fuel and 58,000 tons of fuel oil.

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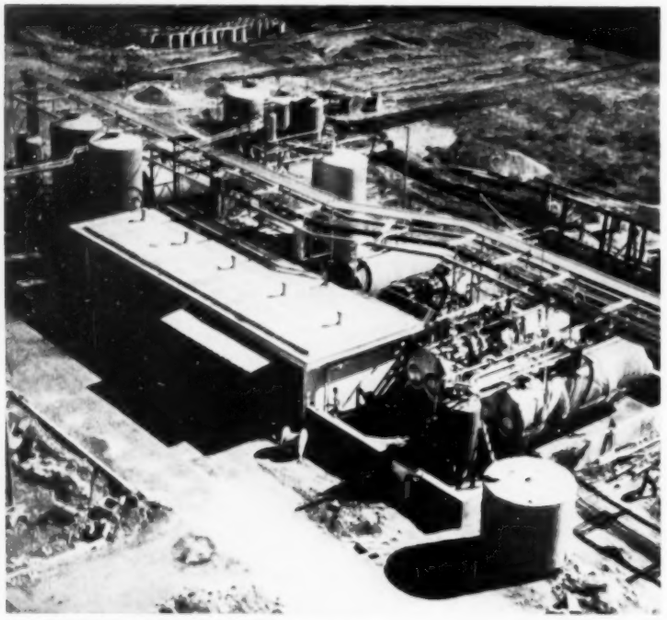
A remarkable increase in crude-processing capacity was also achieved by Union Rheinische Braunkohlen Kraftstoff AG, at Wesseling, near Cologne, which mainly supplies Deutsche Shell AG. The current potential is three million tons a year (about 60,000 b/d)—one million tons more than at the end of 1957.

A considerable expansion took place at Mobil Oil AG's refinery at Bremen-Oslebschausen, with a current annual capacity of 1.5 million tons (about 30,000 b/d), against 0.7 million a year previously. The



Aerial view of a butanol plant under construction. Photo courtesy Friedrich Uhde GmbH, Dortmund.

Heide plant of Deutsche Erdoel AG also doubled its capacity—now amounting to 1.5 million tons annually. At Heide, a catalytic gas-oil desulfurizer, with annual capacity of 370,000 tons of diesel and domestic fuel oil, also was put onstream. With two-thirds German and one-third foreign crudes, percentage recovery of products at Heide is 5% light gasoline, 25% carburetor fuel and jet fuel, 26% diesel or light fuel oil, 3% lube-oil distillates, 25% heavy fuel oil, 5% asphalt, 4% LPGas or gases for the petrochemical industry, and 7% other products.

Within the next two years, completion of three new fuel-oil refineries will result in a further large increase in refining capacity. In the summer of 1959, Purfina Mineraloelraffinerie AG's plant at Duisburg-Neuenkampf will be put onstream with an initial annual capacity of about one million tons (about 20,000 b/d) of crude. In 1960, completion of the Godorf (near Cologne) fuel-oil refinery of Deutsche Shell AG is anticipated. Initial capacity will be four million tons (about 80,000 b/d) of crude.

On the northwestern edge of the Ruhr area, near Dinslaken, BP Benzin und Petroleum AG, affiliate of British Petroleum Co., is building a fuel-oil refinery with a potential annual processing capacity of four million tons (80,000 b/d) of crude. This also will be completed in mid-1960. Recently, some details on the processing facilities of BP were published. Crude from Iran, Iraq, and Kuwait is to be refined at Dinslaken. Two distillation units, each with a daily capacity of 7,000 tons, are being built. A catalytic reformer (throughput 500,000 tons annually) is to improve the quality of the raw gasoline. A Hydrofiner for desulfurizing gas oil is being designed for an annual throughput of 450,000 tons. Recovery is to be 3% propane-butane; 10% to 15% motor gasoline; 8% to 12% light gasoline for the petrochemical industry; 4% to 6% kerosine; 15% to 26% diesel oil and light fuel oil, respectively; 40% heavy fuel oil; and 5% refinery gas, the works' own consumption and losses.

With support from the provincial government and Aminoil, it is likely Gottlieb Duttweiler (Swiss) will be able to proceed with the refinery project at Emden harbor (North Sea coast). This plant, to be completed in 1961, is to have an annual crude capacity of 1.5 million tons (30,000 b/d).

Up to now, the southern part of the federal republic, viz., the provinces Bavaria, Baden-Wuerttemberg, Rhineland Palatium, and Hesse, have been supplied principally with petroleum products from the North German refineries; and, in the case of direct imports, from the North Sea harbors. Some motor fuels and fuel oil have come also from Italy, Austria, and some countries in the Soviet bloc.

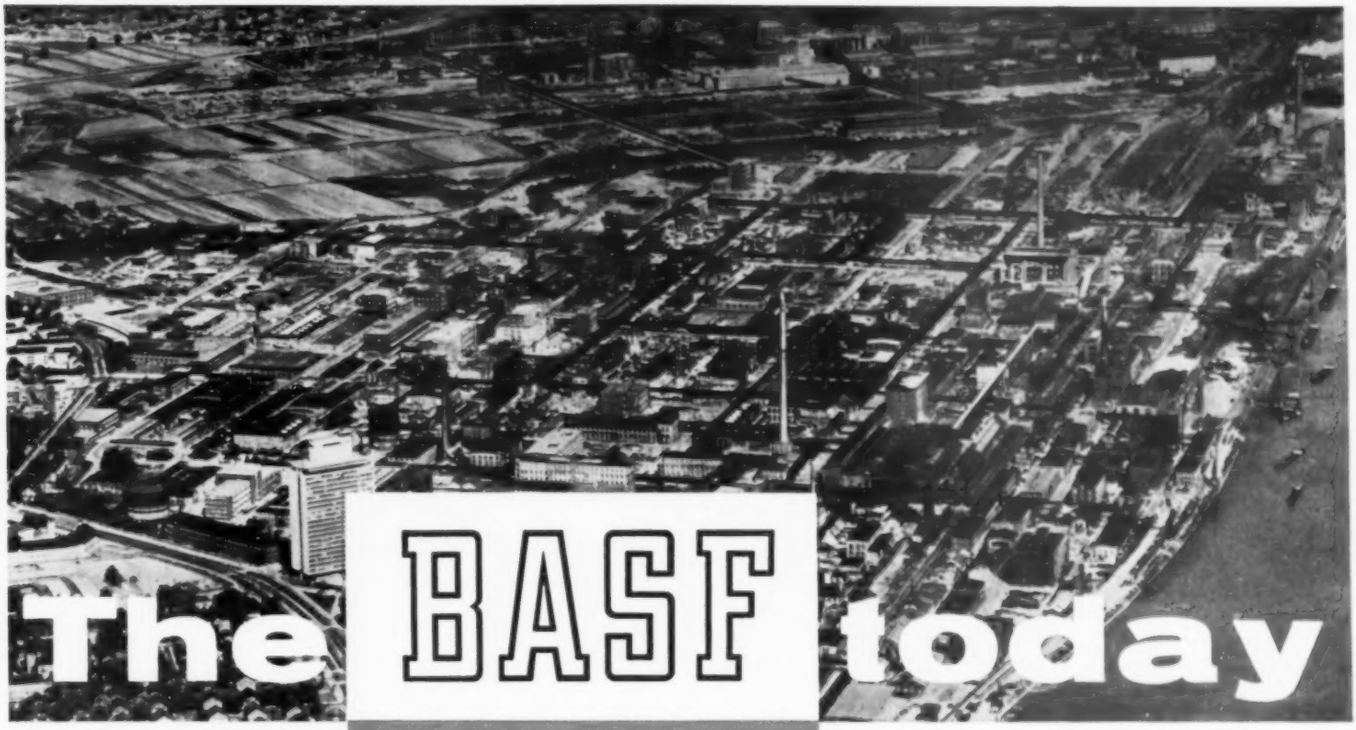
In August 1958, the Ste. du Pipeline Sud-Européen was organized in Paris to investigate and make preparations for laying the long-contemplated pipeline from Marseille to the Upper Rhine. In addition to the well-known international oil companies, interest in the joint project also came from some German interests, viz., Deutsche Erdoel AG, Gelsenberg Benzin AG, Mobil Oil AG (Germany), Scholven-Chemie AG, and Wintershall AG. Almost simultaneously it was announced that Deutsche Erdoel AG intended to build a fuel-oil refinery at Karlsruhe which, together with Strasbourg, may be the terminal of the Marseille pipeline. Annual crude throughput capacity of the new refinery is to be 1.5 to two million tons (30,000 to 40,000 b/d). It is possible that, in addition to the aforementioned companies, other German companies may participate in the Karlsruhe project.

Esso AG also is considering the purchase of a site north of Karlsruhe for expanding a new mineral-oil processing plant on the Upper Rhine. Thus Karlsruhe, together with Strasbourg, on the French side—where some other international oil groups intend to erect additional refineries—may become a new refining center in the heart of Europe. Beginning with 1963, when completion of the Marseille pipeline is planned, not only southern Germany, but also the eastern parts of France and the north of Switzerland, may be supplied in the future. While Marseille will be the import point for the crude which will be processed in Karlsruhe, the new works on the Lower Rhine and the hydrogenation works and refineries in the Ruhr district are now linked with Wilhelmshaven harbor on the North Sea coast by the recently completed 242-mile pipeline, or will be supplied via the new pipeline from Rotterdam to Cologne-Wesseling now being built and to be finished in 1960.

Table II gives a breakdown of the German refinery production in 1957 and 1958. In 1957, fuel oil ranked third after diesel oil and motor gasoline. By 1958, it had risen to first place. In 1959, the output of fuel oil should be nearly as great as combined output of motor fuel and diesel oil. This indicates an important structural change in refinery production over a remarkably short period.

Although indigenous crude production in West Germany is growing steadily—amounting to 4.4 million tons in 1958 (about 88,000 b/d)—it cannot keep pace with the rapid rise in demand and consequent refinery output. As a consequence, the percentage of German crude in total refinery throughput declined to 29.2% in 1958 from 32.7% in 1957. For the current year, the share which can be kept will be less than a quarter. The processing program of the Arbeitsgemeinschaft Erdoelgewinnung und Verarbeitung (AEV) anticipates an annual intake of 4.7 million tons (94,000 b/d) of German crude, 11.7 million tons (234,000 b/d) of Middle East crude, and five million tons (100,000 b/d) of Venezuelan crude for 1959

END



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Developments and prospects of petrochemistry in West Germany

by Dr. Alfons Metzner, Frankfurt a/Main

THE chemical industry of the German Republic reached a new peak in 1958 with a total turnover of 18 billion DM. Chemical production was about 140% higher than in 1938, while total industrial production was only doubled in the same period.

After the war the German chemistry situation seemed hopeless. Military interference during the conflict and dismantling after the war caused the industry heavy losses. In addition many important chemical plants which formerly supplied Western Germany with basic chemicals and fertilizers, were in the sphere of Russian influence. The chemical industry of the Federal Republic had to be rebuilt. For political and financial reasons, reconstruction could not be undertaken before 1950. To meet quickly the competition of foreign producers, relatively large investments had to be made. The average annual investment in recent years has been about 1,500 million DM.

For the same reason research was given great attention. Five percent of the cash flow is spent yearly for research purposes by the most important chemical plants. These high expenditures are essential, because energy and raw material sources are costly.

From Coal to Crude Oil

Germany's development of organic chemistry proceeded in the following stages: About a hundred years ago, coal tar was the only organic raw material used by the dye and pharmaceutical industry. Fifty years ago another raw material was added, which was exclusively derived from calcium carbide. Commercial acetylene chemistry first developed in the 1920's and 1930's, including many side branches. We recall here, the synthesis of Buna rubber (acetaldehyde-aldole-butylene-glycol-butadiene) and the Reppe chemistry of the "Badischen Anilin and Soda-Fabrik A.G." in Ludwigshafen. At the same time, more attention was directed to the chemistry of carbon monoxide and high pressure catalysis. The ammonia, the menthanol and the benzine syntheses were at their highest point of development. Large molecule chemistry, especially plastics became more important in the 1930's. Acetylene was still the main source of raw material. Since plastics and synthetic fiber gradually became cheap commodities, German chemistry had to survey new sources of raw material. Coal had become too expensive as a starting point for many products. The United States, which for a long period had been using more and more crude oil and natural gas as raw materials for inorganic and organic synthesis, made competition impossible.

Motorization Promotes Petrochemistry

Competitive positions in other industrial European countries were just as unfavorable. Great Britain decided to follow the example of the USA in building petrochemical plants. France, the Netherlands and Italy followed. In Germany this industrial branch has been active for just a few years. Nevertheless the development has proceeded so rapidly, that today the Federal Republic of Germany, stands first, after England, in Europe. The development was promoted by the boom in motorization and oil processing. Also because the cost of coal rose 300% and electric power 200% the scarcity of these two energy sources led eventually to a shortage in carbide.

Germany's many useful experiments before the war in the utilization of excess hydrogen, worked out in the Fischer-Tropsch synthesis, again could be used. In this connection it may be recalled, that the former I.G. Farbenindustry process, together with the American "Hydroforming process" the German "DHD" process were forerunners of the American "Platforming process" allowing aromatization of aliphatic and naphthenic hydrocarbons to benzene, toluene and xylenes. This process supplies more than a third of the required hydrocarbon benzene in the USA. The surprisingly quick motorization of West Germany caused crude oil refineries to be expanded to a working capacity of 16.59 million tons by 1957. In that year 11.55 million tons of various products were manufactured. By 1961 the West German oil industry anticipates a domestic consumption of 25 million tons, of which 12 million will be fuel oil. Refinery capacity for inland consumption at that time, will be nearly 45 million tons. The proposed development of West Germany's oil refineries is to be seen in the following tabulation.

TABLE I
DEVELOPMENT OF REFINERY CAPACITIES 1957-1965
(in 1000 metric tons per year)

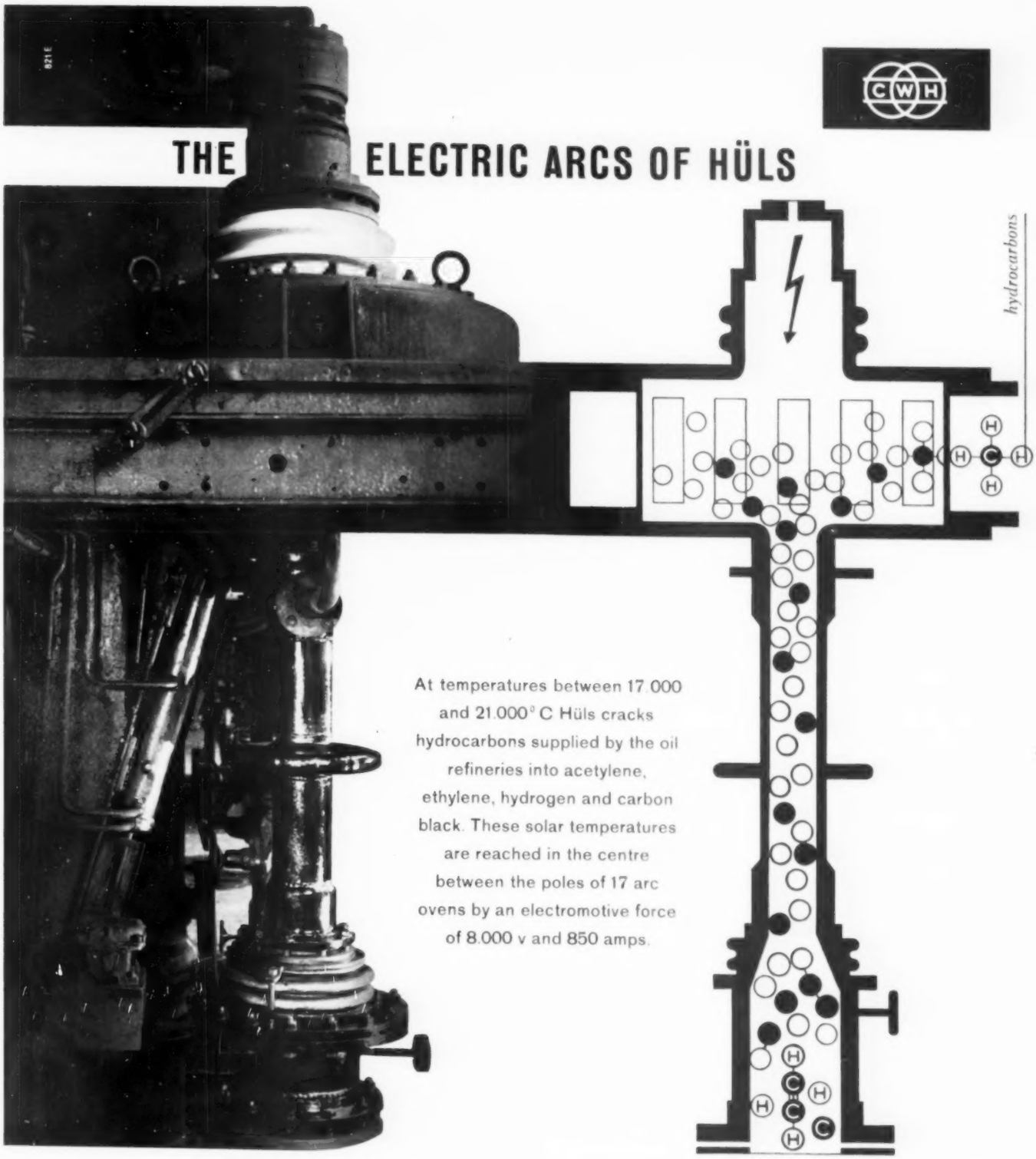
	(Actual) 1957	(Planned) 1961	1965
BASF, Ludwigshafen	48	48	48
BP AG, Hamburg	1,900	2,000	2,000
BP AG, Dinslaken	—	4,400	4,400
Deutsche Erdol AG, Heide (Holstein)	850	1,500	1,500
Deutsche Erdol AG, Werk Karlsruhe	—	1,500	3,500
Deutsche Shell AG, Werk Harburg	900	2,900	2,900
Deutsche Shell AG, Werk Koln	—	4,000	7,000
Deutsche Shell AG, Werk Manheim	260	260	260
Erdolwerke Frisia, Emden	—	1,500	1,500
Esso AG, Werk Hamburg	2,520	3,000	3,000
Esso AG, Werk Koln	—	3,400	7,500
Gelsenberg Benzin AG, Gelsenkirchen	3,300	4,500	4,500
Gewerkschaft Erdolraffinerie DEURAG-NERAG, Miesburg	800	1,300	1,300
Gewerkschaft Erdolraffinerie Emsland, Lingen	800	2,500	2,500
Gewerkschaft Greiff Bergbau, Dollb.	24	24	24
Kraftstoff Handelsges. m.b.H., Essen	80	400	400
Mineralol—und Asphaltwerk AG, Ostermoor	150	250	250
Mineralolwerke Peine	18	18	18
Mineralolwerke A. Sengewald, Dedenheim	42	42	42
Mobil Oil AG in Deutschland, Bremen	770	1,500	1,500
Purfina, Duisburg	—	3,000	3,000
Olwerke J. Schindler GmbH, Hamburg	220	220	220
Ruhrbau Mineralolraffinerie, Muhlheim	300	300	300
Ruhrchemie AG, Oberhausen	375	500	500
Ruhrol, Chemiewerk der Steinkohlenbergwerke Mathias Stinnes AG, Bottrob	120	120	120
Scholven Chemie AG, Gelsenkirchen	1,000	2,500	2,500
Union Rheinische Braunkohlen Kraftstoff AG, Wesseling	2,000	3,000	3,000
Wintershall AG, Salzbergen	105	105	105
Zeller & Gmelin, Mineralolraffinerie, Eislingen/Fils	8	8	8
Total	16,590	44,795	53,895

In 1957 German refineries processed 12.12 million tons of crude oil, 3.96 million tons or 33% of domestic crude, 8.16 million tons or 67% from foreign lands. More than three-fourths of the imported oil came from the Middle East, less than a fourth from Venezuela and the USA. In addition 3.57 million cubic meters of natural gas was processed. Total output of oil products amounted to 11.84 million tons.

The importance of motorization to petroleum chemistry will be understood by the following considerations: Petrochemistry takes its place between the standard oil processing on one hand, and classical chemistry on the other. The industrial task has been the segregation of crude oil into usable single components by physical methods, primarily by means of distillation. Through increased motorization the demand for fuel and lubricants rose steadily. It became impossible to fill the demands for all products by simple distillation. Chemical processing of crude oil components was applied. At last, a whole series of chemical operations found their way into the oil refining industry: thermal and catalytic cracking, hydrogenation and dehydrogenation, alkylation, isomerization, cyclization and polymerization.

The application of these processes and the production and refining of lubricants and fuel do not mean "petrochemistry" to the German way of thinking. Petrochemistry comes into play when by-products of oil cracking are used as raw material for chemicals. Today it is therefore impossible to draw a sharp difference between the chemical and crude oil refining industries. A refinery with a cracking plant which produces fuel oil and chemical raw materials side by side is just as much a crude oil processing plant as a petrochemical plant. In Germany there naturally rose in addition to dual purpose plants, strictly petrochemical processes by means of which the production of chemicals from crude oil and natural gas is the exclusive purpose. The following petrochemical operations are important for Federal Germany.

1. Production of olefins.
2. Production of synthetic gas to manufacture ammonia, methanol, and its by-products (hydrogen from natural gas, crude oil, cracking and benzene fractions).
3. Conversion of methane (cracking, partial oxidation and obtain-



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ing acetylene, halogenizing, conversion with ammonia to hydrocyanic acid).

4. Production of acetylene from liquid raw materials.

The petrochemical production of aromatics, which plays a great role in the United States, is yet of no importance in Europe.

Favorable Base for Petrochemistry

The rising oil production and discovery of domestic natural gas, especially the extensive building of refineries provide a healthy base for the development of petrochmistry. In contrast to the USA, Germany's combined domestic and imported crude and partly refined oils have not yet brought about sufficient consideration of the complicated chemistry of aromatics or heterocyclics. Organic dye substances or vitamins are not petrochemically produced. On the other hand, cleaning substances and most plastic raw materials with simple chemical structures are typical goals for petrochemistry.

Although the demands of modern motors on individual oil products have become more rigid the experience of the chemical industry and research have developed methods of splitting crude oil into well defined fractions. Useful chemicals for research in plastics, solvents or synthetic fibers, are present. The immense size of modern refineries made it possible to produce these useful chemical substances simultaneously in large quantities, and in sufficient purity.

In processing crude oil many fractions are produced, some of which are always in strong demand, while other fractions are not easy to sell. Sometimes these by-products are not saleable while at other times, they are very much in demand. Worry about these by-products has been the cause of important technical advances.

When a chemical plant buys petrochemical raw material, it saves itself the trouble of storing these by-products on one hand, but there exists the danger, that each partner misses the possibilities of the other. As a result either a petroleum refiner organizes a chemical division, or a chemical firm becomes a crude oil refiner. Since a project of this kind requires very large capital investment only great concerns are able to do so.

Cooperation with the Petroleum Industry

Germany's petrochemistry has taken another direction which led to a quicker goal and seems to be more economical. For solution of great petrochemical problems, oil and chemical companies, coordinate. The first petrochemical development in Germany was by "Chemische Werk Hüls A.G., Marl, (CWH)". This plant processed waste gas from synthetic fuel oil, produced by "Schalven and Gelsenberg-Benzin, which since 1944 also processed large quantities of Emsland natural gas. Possibilities for cooperation with other companies became apparent during the reconstruction building period in the 1950's.

Many technical problems had to be solved when the first union of chemistry and crude oil was undertaken about six years ago. Great obstacles in the path of the infant petrochemical industry were put in its way, such as mineral oil duties and tax laws.

It was difficult to convince the State that new technical developments were being choked at the start by duties and consumer taxes. It was seriously suggested that industry proceed with petrochemical developments and that the State would, in case of economic recession, assure productiveness. Fortunately, the State was convinced that the primary incentive for development, could never be regained by such economic emergency measures. When at last all obstacles were removed, favorable conditions for very important petrochemical developments were at hand.

Rheinische Olefin Plant (GmbH)

The first step in this direction was made by the "Deutsche Shell AG," Hamburg (SHELL) conferring with the "Badische Anilin and Soda Plant A.G.," Ludwigshafen (BASF). It was discovered that SHELL in Wesseling, Cologne had great quantities of refinery tail gases from which 20,000 tons of ethylene per year could be produced.

In connection with laboratory tests begun in 1938, BASF had built a pilot plant for polymerization of ethylene under pressure. The process designed by chemists of BASF was tested on a semicommercial scale to determine its possibilities. The process uses the same high pressure method patented by the English "Imperial Chemical Industries Ltd." London (ICI) licensed for use in Germany under contract with BASF.

Cooperation between BASF and SHELL and the founding of the "Rheinische Olefinwerke GmbH, Wesseling, county Köln (ROW) began in the fall of 1953. Within 22 months a new plant was built in Wesseling, which started large scale production of polyethylene.

These plants for producing high-pressure polyethylene have been enlarged several times since then. After completion of the present plant construction capacity will be 35,000 tons yearly. At the same time a plant is under construction for producing low pressure polyethelene, by the Phillips method. Capital requirements are 27 million DM. Probable output capacity will be 6,000-10,000 tons yearly. Operations are expected to begin sometime in 1959. BASF received a license in 1956 from Phillips Petroleum Co., Bartlesville, Okla. Previously low pressure polyethylene was produced by BASF only in a pilot plant. Types of Polyethylene produced at Wesseling are supposed to complete the expanded "Lupolen" assortment of BASF for products of higher density.

To obtain raw materials for the ROW plant a new light cracked gasoline plant (Kellogg-Cracker) was built. Operations began at the end of 1958.

Ethylbenzene too, is included in the production program of ROW which after dehydrogenation, becomes styrene. This in turn becomes the raw material for one of the most important plastics of BASF, namely polystyrene. Ethylbenzene is produced from petrochemical ethylene, derived from coal tar. This is an impressive example in connection with the much older usage of coal tar and the newly developed petrochemistry. The examples of polyethylenes and polystyrenes show that mass production of plastics in Germany are unthinkable without the help of petrochemical substances.

Valuable intermediates such as benzene derived from coal tar are still very important for many plastics and fibers. Further exploitation of coal tar with its inherent aromatic connections are naturally limited by coal production and coking, for the iron and steel industry.

The utilization of olefines in recent years shows a list of other very interesting new developments. It was already known from work at BASF before the war, isobutylene could be produced by dehydrogenation of isobutane, and that high pressure synthesis of coal oxide and hydrogen changed isobutylene into its polymers. Polyisobutylene "Oppanal" has been long known as a valuable substance for building materials and sealings (waterproofing of foundations, tunnels, subways; lining of apparatus, and gumming).

Petrochemistry is able by a long known method to furnish the raw material, isobutylene. Just like isobutylene, other gaseous olefins, especially ethylene and propylene can be produced by methods whereby either crude oil, or less suitable oil fractions are split so as to make the desired raw material for petrochemical synthese.

Farbserke Hoechst AG.

This firm has developed a cracking process for manufacturing gaseous products and petroleum coke which is suitable for electrodes. The gas produced contains olefins which are partly processed to produce polyethelene (by the Ziegler method) and polypropylene. By isolation of olefins a residue gas is left for utilization in ammonia synthesis. In 1958 the plant produced over 10,000 tons of polyethylene. Enlargement of the plant for polypropylene, to a capacity of 7,000 tons was completed in December 1958. The plant in Hoechst known as "Hoechster Koker" is able to produce over 20,000 tons of ethylene, propylene, and other unsaturated hydrocarbon yearly. In the same plant is a tube still heater in which ethane and propane are split to ethylene and propylene, by which the total production of olefins is raised to 25,000 tons yearly.

To extend its raw material base the "Farbwerke Hoechst A.G.," which belongs to the most important carbide producers of West Germany, is building a plant for production of acetylene the petrochemical way. With expenditures totaling 60 million DM, a high temperature cracking plant is being built, for producing 50,000 tons of acetylene and ethylene. Operation of the plant will begin this year with an olefin output capacity of 70,000 tons yearly.

Erdol-Chemie KmbH (Crude Oil-Chemistry)

Although Hoechst has thus far operated individually—"Farbenfabriken Bayer A.G.," Leverkusen (BAYER), has combined with "BP Benzin and Petroleum A.G.," Hamburg. Both partners founded "Erdöl-Chemie GmbH," and at Dormagen in 1958 built a cracking plant for producing all sorts of olefins for various organic chemicals.

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Ethylene and ethylene oxide also will be produced there. Ethylene oxide has become interesting from the chemical point of view in Germany. It was first recovered in experiments at ASF where alcohol was split to ethylene and so converted to ethylene oxide. Later on ethylene raw material was used for the production of ethylene oxide. For example, this is being done at "Chemische Fabrik Holten GmbH," Oberhausen-Holten, where instead of coking gas ethylenes, a German refinery ethylene is used. A change of method was partly necessary.

Cooperation "Esso-Hüls"

Interesting cooperation exists between different oil companies of West Germany on one hand, and the chemical Werke Hüls AG. Marl, and the Bunawerke Hüls GmbH, Marl on the other. Under long term contracts the plants in Marl will receive a series of basic chemicals from West German refineries, such as Esso, BP and Mobil Oil. The plants of "Buna Hüls GmbH" have been in operation since the middle of September 1958.

The estimated capacity of these plants is 45,000 tons per year of synthetic rubber of the cold type. Necessary for this output are 32,000 tons per year of butadiene and n-butane and 10,000 tons per year of styrene. In addition 6,000 tons per year are to be produced for other purposes. The total butadiene production is estimated at 38,000 tons per year. It is hoped that the capacities of these plants will be increased partly by better process conditions and partly by other improvements. The polymerization plant capacity is estimated at 70,000 yearly tons. A future total of 90,000 tons is anticipated. Raw materials for synthetic rubber are n-butane supplied by the refineries, and styrene from the chemical plants of Hüls. Another reason for enlarging the styrene plant to 72,000 tons per year is the demand for raw material by Buna Hüls GmbH.

Normal capacity of 45,000 tons is at this time impossible as West Germany's rubber industry is still bound by long term important contracts. But this is a passing situation. Top production is planned for an early date. At this time, six different types of Buna rubber are produced. The principal variety is type 150, which is mainly used for tire fabrication, type 152 for technical and light rubber articles and three types of latex.

The above types are plasticized with a variable oil content. Laboratory controls are maintained of soot filled types. This new plant is wholly automatic. Only 400 people are needed for continuous production at Hüls GmbH. Since the total investment is 114 million DM each worker requires an investment of 300,000 DM. Additional sub plants costing 36 million DM for butadiene production, butadiene concentration, the polymerization plant, storage for intermediate and finished products have been built. Auxiliary plants produce power and steam under contract. With a working capital of about 30 million DM the capital requirements of "Buna Hüls GmbH" total 180 million DM. Financing of over 42 million DM has been obtained by long and medium term loans. Of the production costs; 40% are for raw material, about 15% for interest on capital loans, and 27.5% for production costs. The production costs include wages of about 3 to 5%.

With financing completed the chemical plants of Huls AG. continued their petrochemical program. As a result plants are being enlarged for the production of acetylene from methane and liquid gases (by the electric arc method) and ethylene oxide. New methods of producing polyethylene also are being introduced.

Something About Propylene

Propylene has been known in Germany for many years. One of the first and easiest conversions of propylene was the conversion to isopropanol and acetone. Shortly before the war independently of the German BASF and the American "Shell Chemical Corp.," a glycerine synthesis of propylene was developed. In Germany as well as in the USA large plants were built. Since the German glycerine plants were lost on account of the war, the plants in America have developed so that today more than 40% of the glycerine requirements from conversion of propylene are covered there.

An intermediate product of the glycerine synthesis is, the varied use of epichlorhydrin which contains an essential part of the Shell developed Epikote resin. With experience of Shell, a plant for the production of Epikote resin has been built by the previously mentioned "Rheinische Olefinwe' GmbH" in Wesseling, which has been in operation since the end of 1958 with a yearly capacity of 2,000 tons.

TABLE II

Production of intermediates for Conversion into Organic Chemicals (in metric tons)

	1950	1954	1955	1956	1957
Federal Republic Germany					
Carbon monoxide	85,000	240,000	270,000	—	260,000
Methane	2,000	5,000	7,000	—	13,000
Acetylene	90,000	160,000	185,000	—	185,000
Ethylene	25,000	45,000	50,000	—	70,000
Propylene	1,000	15,000	18,000	—	40,000
Benzene	45,000	120,000	145,000	—	190,000
Naphthaline	30,000	50,000	60,000	—	70,000
USA					
Methane	280,000	860,000	450,000	—	460,000
Acetylene	100,000	190,000	220,000	—	260,000
Ethylene	700,000	1,100,000	1,400,000	—	1,800,000
Propylene	300,000	550,000	600,000	—	700,000
Benzene	700,000	900,000	1,100,000	—	1,200,000
Naphthaline	180,000	170,000	270,000	—	240,000
France					
Acetylene	—	35,000	50,000	50,000	54,000
Ethylene	—	3,000	11,000	14,000	18,000
Propylene	—	17,000	26,000	30,000	33,000
Benzene	—	40,000	51,000	60,000	72,000
Naphthaline	—	26,000	35,000	27,000	24,000

By simple deposits of carbon monoxide and hydrogen, it is today possible to produce the intermediate products of butylaldehyde, n-butanol and isobutanol—which can be used as solvents, softening components and for many other purposes. For high molecule alcohols, there exists the analogous method of combining carbon monoxide and olefins of medium molecule weights, in the range of 6-9 atoms of carbon for example. These are the petrochemical Oxo-methods, which are applied in great quantities, at BASF in Ludwigshafen.

Another recent development involves the production of synthetics and synthetic fibers for instance acrylic acid acrylonitre and methyl-ester of methacryl oxide, and great quantities of hydrocyanic acid. Two of the BASF developed methods—for the production of free hydrocyanic acid have been in existence for many years. One of these follows the Formami step, which employs carbon monoxide and ammonia. The other conversion uses methane and ammonia.

Both methods were originally developed on the base of coal chemistry, i.e. from coke and coking gas. Röhm and Haas GmbH, Darmstadt, for example succeeded in processing methane by a special method. At that time there was no commercial value because methane could not be obtained cheaply enough through coal chemical processes. Originally there was only one method for producing free hydrocyanic acid in great quantities and this method is still being applied at BASF, with carbon monoxide, ammonia and methanol as raw materials.

When after drilling for crude oil in Hessen, methane was available in great quantities, the process discovered by BASF and further developed by Röhm and Haas attained great practical importance. It is now applied in one of their plants in large quantities.

Statistics of Petrochemistry

The petrochemical production of the Federal Republic from 1953 until 1957 has tripled Organic synthetic chemistry constituted one fourth of the production. Of the total petrochemical production of West Europe, Germany's output was nearly 27%.

In 1960 German production will be more than double. This production increase will not be as large as in France, where combined with the great natural gas reserves in Lacq, production is expected to be four times as high. Great Britain, previously the largest producer, will produce a somewhat smaller share as will be seen in the following tabulation.

Petrochemical production in West Europe

in 1,000 ton carbon capacities

	1955	1956	1957	1958*	1960*
Federal Republic	110	134	166	187	395
France	36	50	80	141	400
Italy	26	39	73	131	171
Great Britain	198	219	274	327	301
Netherlands	27	31	36.5	44.5	56
Belgium					17

*Planned.

TABLE IV

Comparison of Coal and Petrochemistry in Germany
1957 Production of Chemical Intermediates for
Conversion to Organic Products

Product	Total	Base: Coal	Base: Crude Oil Natural Gas
Carbon monoxide	260,000	225,000	35,000
Methane	13,000	1,000	12,000
Acetylene	185,000	125,000	60,000
Ethylene	70,000	30,000	40,000
Propylene	40,000	—	40,000
Butylene	10,000	—	10,000
Aliphatic hydrocarbons with 5 and more atoms of carbon	18,000	11,000	7,000
Benzene	190,000	190,000	—
Toluene	20,000	17,000	3,000
Xylenes	6,000	5,000	1,000
Naphthalene	70,000	70,000	—
The products may be combined to give the following totals.			
West Germany			
tons	882,000	674,000	208,000
tons C content	675,000	507,000	168,000

In 1957 Petrochemistry in West Germany supplied 24% of the tonnage of organic-synthetic chemistry and 25% of the carbon content.

Germany's share of the total organic petrochemical production will increase greatly until 1960, but considering conditions, it will never be possible to obtain America's level. In the following table are figures of primary products converted to-organic by-products in the USA, Germany and France.

Figures for the Federal Republic of Germany have been combined from all West German production companies. Figures for the USA have been partly calculated, partly estimated from published production figures.

The relatively small role played by acetylene chemistry in the USA is recognized at once, but also the noticeable fact, that it has developed more than in West Germany and in France, where it grew little, or not at all. In the USA acetylene chemistry has held its pace with general development in the organic sector, but lost ground in both European countries to other aliphatic branches. For easier global conception of the following table, actual quantities of intermediate chemicals, are shown in metric tons—as is usual with OEEC in the sphere of petrochemical production.

TABLE III

1957 Production of Petrochemicals
(Figures in tons of carbon content)

	Aliphatic chemicals C_1 Carbon monoxide and methane	C_2 & C_3 Acetylene Ethylene Propylene	Aromatic chemicals Benzene Naphthalene
USA	375,000[1]	2,145,000[2]	1,335,000
Federal Rep. Germany	130,000	265,000	240,000
France	—	95,000	90,000

1) Excludes carbon monoxide
2) Includes ethanol

The preponderance of aliphatic chemistry in the USA is outstanding as compared with aromatic (eliminating the C_1-column) while these two sections in West Germany and in France are about equal. In 1950 the difference between these aromatics (800,000 tons C) and the C_2 C_3 column (900,000 tons C) were also relatively low. The Federal Republic of Germany still exceeded this aromatic column (about 130,000 tons C). The C_2 C_3 column (105,000 tons C).

The approximate quantity positions of national production volume is very impressive. Even neglecting the quantities of carbon monoxide in USA organic chemistry the quantity of about 4.2 million tons C. is almost seven times as large as West Germany's (including carbon monoxide).

Table IV at the left shows eleven important primary chemicals in which chemistry of coal and petrochemistry are compared.

Roughly stated the difference of 1% can be left off to save figuring the carbon content. One can therefore say, that in the Federal Republic of Germany in 1957 Petrochemistry and coal chemistry were about 1:3. This condition will shift in the future in favor of petrochemistry.

TABLE V

Coal and Petrochemistry in the USA
Quantities of Chemical Intermediates for
Conversion to Organic Products
(Year 1957 in Tons)

Product	Total Quantity	Basis: Coal	Basis: Crude Oil Nat. Gas
Carbon monoxide	—	—	—
Methane	460,000	—	460,000
Propane	125,000[1]	—	125,000
Acetylene	255,000	175,000	80,000
Ethylene	1,790,000	—	1,790,000[2]
Propylene	700,000	—	700,000
n-Butylene	422,000	—	422,000
i-Butylene	141,000	—	141,000
Aliphatic hydrocarbons with 5 or more hydrocarbon atoms	—	—	—
Benzene	1,200,000	850,000	350,000
Toluene	143,000	18,000	125,000
Xylenes	210,000[3]	20,000	190,000
Naphthalene	233,000	233,000	—

1 Propane-propylene mixtures.
2 A small quantity of coke gas.
3 Assuming that about 25% of domestic market supply was used for chemical purposes.
4 Assuming that about 50% of domestic market supply was for chemical purposes.

American output quantities are from official production statistics, derived by calculation and estimates and may be summarized as follows:

USA 1957	Total	Basis: Coal	Nat. Gas Crude Oil
tons effective	5,650,000	1,300,000	4,350,000
tons C-content	4,950,000	1,200,000	3,750,000

The comparison shows that the production volume of organic synthesic chemistry in the USA is seven times as large as in the Federal Republic of Germany. Petrochemistry alone is 22 times larger than in Germany. The proportion of petrochemistry to coal chemistry for the USA in 1957 was: effective quantities 77% and C-content 76%. Relative quantities in the USA are the reverse of those in Germany. The USA ratio between petrochemistry and coal chemistry is 3:1.

Prospects of German Petrochemistry

The importance of petrochemistry in Germany is seen from the fact that in a few years nearly a billion DM has been invested in the industry. Future development is expected to move in various directions. Of most immediate importance is plastics because of the great variety of new items produced by the chemical industry for daily life.

It is very probable that many older production processes for instance, tar dye stuffs and pharmaceuticals, both primary and intermediate products, which are the result of pioneer inventions, will be influenced by new petrochemical developments.

The post-war plants of "Phenol Chemie GmbH" in Zweckel, where phenol is produced from petrochemical propylene, and coal tar benzene are examples of this trend. Another characteristic example is the transfer of results of petrochemistry to the ammonia synthesis, which was originally developed from coal chemistry. Lately, at BASF, as at Hoechst considerable quantities of ammonia, for fertilizers are obtained from petrochemical raw materials.

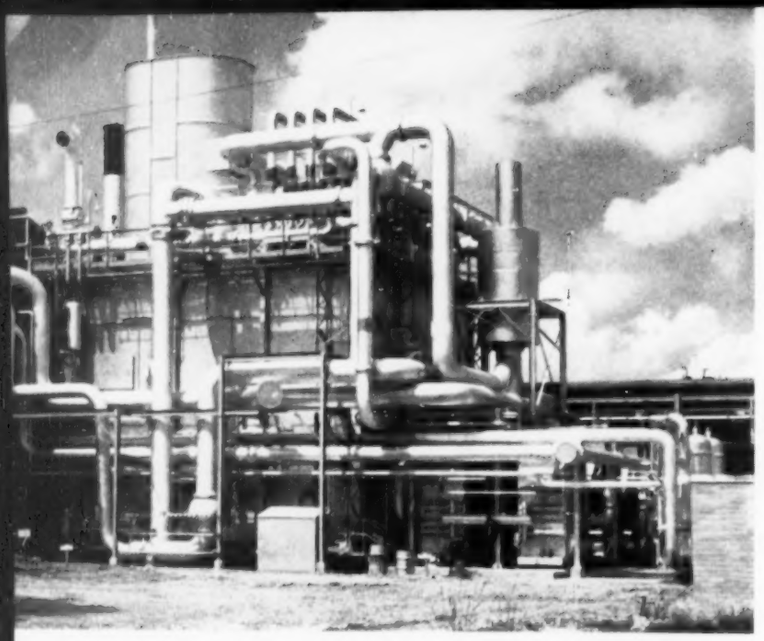

Fig. 1: View of a plant for the production of about 300 tons/day of 95% purity oxygen, built by Linde in U.S.A.

Linde -low temperature techniques in petrochemistry

by Dr. Ing. Johannes Wincherer

The development of petrochemistry has forced the petroleum technologist to use technical processes with which he had no previous experience. Among these are low temperature techniques which have a certain similarity to processes used in the petroleum industry, in that they involve manipulation of the same physical equipment such as heat exchangers, fractionating columns, piping etc. This similarity, however, does not extend to the process as a whole, nor to the design of individual parts of the equipment, nor to the general layout of the plant. Therefore, as a rule, such plants are built by firms which have specialized in low temperature technology. The Gesellschaft für Linde's Eismaschinen Abt. Gasverflüssigung, at Hollriegelskreuth near Munich, has been engaged in the construction of low temperature plants for more than 50 years.

High temperature petrochemical processes generally obtain the best results through the use of oxygen for a partial burning of natural gas, petroleum oil or their derivates; reference may here be made to the partial combustion of natural gas for obtaining acetylene, and to the pyrolysis of petroleum for the production of acetylene and ethylene. Oxygen is obtained by fractionating air at low temperature by means of distillation. Linde was the first firm (1930) to build tonnage oxygen plants and has the credit for the largest number of plants with a capacity of up to 350 tons of oxygen per day. All these plants operate by the Linde-Frankl process which, as main heat exchangers, uses regenerators instead of tubular heat exchangers. The self-purifying action of these exchangers permits dispensing with preliminary drying and purification of the air and, thus, with the use of chemicals. Control and regulation of the regenerator temperatures is fully automatic. Automation of the remaining controls of the plant offers no difficulty but is, however, seldom carried through as the plants—also in the absence of such equipment—require but a minimum of attendance.

Far-reaching precautionary measures have been taken to guard against hazards that may arise from certain impurities in the air (particularly hydrocarbons) during the operation of an air separating plant. Only under particularly unfavorable conditions is it necessary to provide special precautions outside the plant, e.g. long air intake pipes. All oxygen purities, from 70% up to 99.5% and more, can be produced economically. In many petrochemical plants hydrogen occurs as a byproduct. Where this is the case, the oxygen plant can, at no appreciable additional expense, simultaneously produce a sufficient quantity of pure nitrogen which, along with the hydrogen, makes ammonia synthesis gas. Linde oxygen plants are simple in construction. They consist essentially of an air compressor (turbo type), a cold box, and expansion turbines; Linde oxygen plants are therefore hardly ever affected by disturbances.

The synthesis gas for the ammonia synthesis must invariably be thoroughly purified, especially must all traces of carbon monoxide and oxygen be removed. This is most efficiently done by scrubbing with liquid nitrogen at a temperature of about 90 K. The advantage of the liquid nitrogen wash over the customary chemical wash processes is that, in addition, it also removes other inert gases from the mixture. A residual CO content of less than 5 ppm and a content of other inert gases (especially methane and argon) under 100 ppm, gives the most favorable conditions for an economical ammonia synthesis. The nitrogen wash was also first used by Linde (1926) and has since then formed part of numerous plants.

These nitrogen wash plants are generally operated as fully independent plants; here, a HP-nitrogen cycle is not only the source of refrigeration but also supplies the liquid nitrogen for the washing process and for the make up of the synthesis gas. However, it is also possible, by proper arrangement of the air separation plant and nitrogen wash plant, so to combine both plants that only one source of refrigeration will be necessary and that, in specific cases, even the nitrogen compression may be dispensed with.

In recent years, ethylene has become one of the most important raw materials for the manufacture of synthetic products. Ethylene can be obtained in many ways: by dehydration of ethyl alcohol, by hydrogenating acetylene (obtained from calcium carbide), by separation from coke-oven gas and finally from gases produced either by refinery techniques or through high temperature pyrolysis of petroleum or its derivatives. The first two sources of ethylene mentioned above are becoming less and less important since they are relatively expensive and consume valuable raw materials. The production of ethylene from coke oven gas dates from about 1935. In the coke oven gas separation for the purpose of obtaining an ammonia synthesis gas it is easy to get a fraction rich in ethylene from which pure ethylene can then be produced by the low temperature process. Only in recent years has it become possible to economically produce ethylene from coke oven gas without completely separating this gas into its constituents.

After Linde had developed the basic steps for the production of pure ethylene, a new problem presented itself: to process a gas that originated from the thermal dissociation of ethane and which contained a considerably higher content of hydrogen than the ethylene fraction obtained from coke-oven gas. This problem was solved in 1938. After the war, the process was developed mainly in the direction of higher purity and better yield of ethylene. Further improvements resulted in plants the yield of which was satisfactory even at varying quantity and composition of the raw gas. This result was mainly due to extensive automation.

In the following years, a large number of plants were built which were designed to process completely different fed gas mixtures. The analyses for some typical cases are given in Table 1. In spite of this variability the process remains basically the same. Specific instances may, of course, require certain modifications.

The crude gas, if not already under pressure, is compressed to a pressure which, depending on its composition, is within 20 and 30 atmospheres (280—440 psig). Then the gas is cooled in stages to about —40 C (—40 F) with the help of an ammonia refrigerating machine or a propane-propylene cycle, water ice and hydrocarbon hydrates being removed from the gas in interchangeable coolers. Suitable pressures and temperatures ensure that all C_5 and higher hydro-

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Fig. 2: Shop erection of a plant for the production of 15,000 tons/year of pure ethylene, built for a German petrochemical works.

carbons, together with part of the ethylene, ethane and methane, are condensed from the gas. In settling containers the condensate is separated into water and hydrocarbons; after drying by means of silicagel or some other drying agent, the hydrocarbons are fed to the C_2-column (de-ethanizer), in the bottom of which accumulates the C_2 and higher hydrocarbons, free from C_1 and CH_4. In further columns, this bottom product can be separated into C_2, C_3 and C_4.

The crude gas, now free from C_3, is dried over gel and subjected to further cooling. The end temperature depends on the gas composition and is so chosen that practically all C_2 goes into the condensate. If necessary, the end temperature is reduced to −140°C (−220°F) which is near the methane boiling point to obtain high yield of ethylene, whereas most other processes avoid such low temperatures. The condensate then goes into the methane column (demethanizer) which, at a pressure of 0.5-1 atmosphere (7-14 psig), operates as a rectification column.

The product obtained at the top of the C_2-column goes likewise into the methane column.

The main differences from other processes are as follows:

1) Only very small amounts of inert gases (boiling points below that of CH_4) go to the demethanizer.

2) The methane cycle so fixes the temperature at the top of the column that almost no C_2 can escape.

3) Rectification (instead of the usual wash process with higher hydrocarbons) makes a regenerative column unnecessary.

The very favorable equilibrium C_2-C_1 ensures excellent removal of the methane and a high ethylene yield.

A further step is the separation of C_2H_2 and C_2H_4, the boiling points of which are very close. For this effect, Linde from the beginning has used the following system: A column with an open ethylene cycle operates according to the principle of the heat pump. The pure ethylene leaving the top of the column at slight overpressure is warmed up to ambient temperature, compressed to 80-90 psia, cooled down in heat exchange with pressureless ethylene, liquefied in a tube system in the bottom of the column and having been further cooled down is expanded to the top of the column which has no condenser. Other manufacturers who formerly used wash processes for this separation have lately more and more turned to the procedure outlined above. The same objective can also be reached by means of an ethane cycle; in this case the column has no evaporator but a condenser.

Special emphasis in the use of ethylene for making synthetic products is laid on the absence of acetylene. Because of boiling irregularities of the C_2H_4, $C_2H_4C_2H_2$ mixtures, separation of acetylene and ethylene by rectification is hardly possible. Acetone, being a highly selective washing agent in favor of the acetylene, is therefore made use of. This washing is likewise carried through at low temperatures (−80 to −100°C = −100 to −142°F) and at a pressure of 1, 2 to 3 atmospheres (17-43 psia). Here, special precaution is taken to keep the loss of acetone low and particularly to have the pure ethylene free from acetone. It is possible to keep the acetylene content of the ethylene below 5 ppm.

It is typical for the Linde process that the four steps outlined above do not represent closed systems but that all of them are so combined as to serve diversified thermodynamic purposes, e.g.: raw gas condensation is made use of for the heating of the methane column; the bottom of the methane column, in specific instances, cools the upper part of the C_2-column; the methane cycle furnishes cold not only to the methane column but also for the final condensation from the raw gas. The ethylene cycle also cools the acetone wash column. All this means greater economy of refrigeration and thus a considerable saving of energy. Compared to other systems, the savings are in the order of 25-35%. It is true that the necessity to cope with varying gas compositions, represented a certain difficulty. In the course of time, however, one learned to overcome this problem without prejudice to the inherent advantages of the process and to design the plants in such a way that the individual steps of operation can be introduced in the order required for startup.

For raw gases that contain but small concentrations of ethylene, for instance coke oven gas, a comparatively simple gas enriching process has been worked out that gives a concentration which is suitable for processing in normal ethylene plants.

To increase the ethylene yield, the produced ethane is sometimes subjected to thermal cracking, the cracked gas then being refed to the raw gas. In this way, even at a 50% yield of the cracking installation, nearly all the ethane will be obtained in the form of ethylene.

On this basis, since World War II, Linde has built about 25 plants. Their ethylene quantity ranges from about 100 to 2000 Nm^3/h in the case of customary type plants. The design and construction of units with a capacity of up to 300 Nm^3/h (about 30,000 tons per year) and more offers no difficulty.

Out of the acetone wash herein described, Linde has developed another group of processes which employ this wash process in the production of acetylene from raw gases, e.g. crack gas from natural gas. This process can be combined with the production of ethylene.

Table 1

Examples of ethylene-containing raw gases

Gas	A	B	C
H_2	7,0	14,5	38,8 Vol. %
N_2	0,7	2,0	1,0
CO	0,9	2,2	19,8
CH_4	18,8	29,5	19,5
C_2H_6	44,0	32,3	19,5
C_2H_2	1,5	0,8	0,2
C_2H_4	22,0	2,7	1,0
C_3H_8	3,5	9,1	0,2
C_3H_6	0,8	0,3	—
C_4	0,8	3,9	—
C_5	—	4,6	—
CO_2	—	0,1	—

A Raw ethylene fraction from the separation of coke-oven gas
B Gas from the thermal cracking of gasoline
C High temperature pyrolysis gas (after removal of most of the acetylene)

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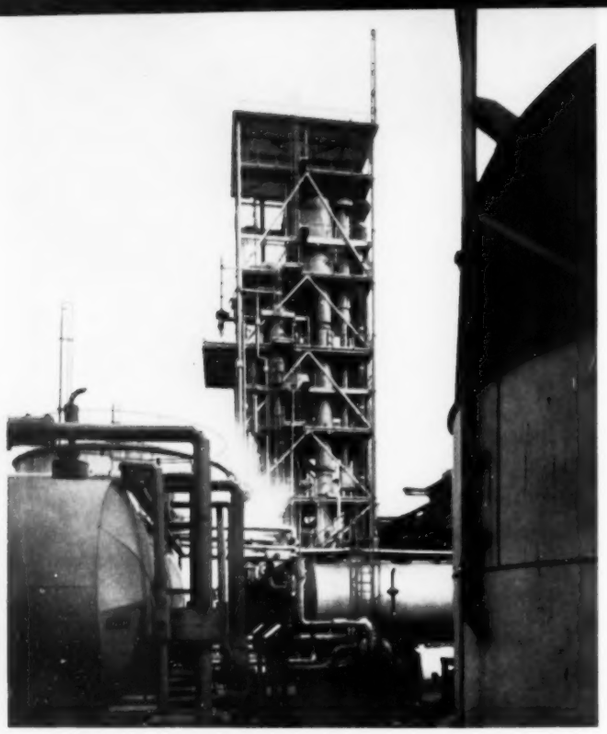


A pilot plant of the Lurgi-Ruhrgas sand cracker, capacity: 24 t crude per day.

IN the past, the production of olefins was generally accomplished by the steam cracking process. This method implies the cracking of gaseous and low-boiling liquid hydrocarbons in tube furnaces.

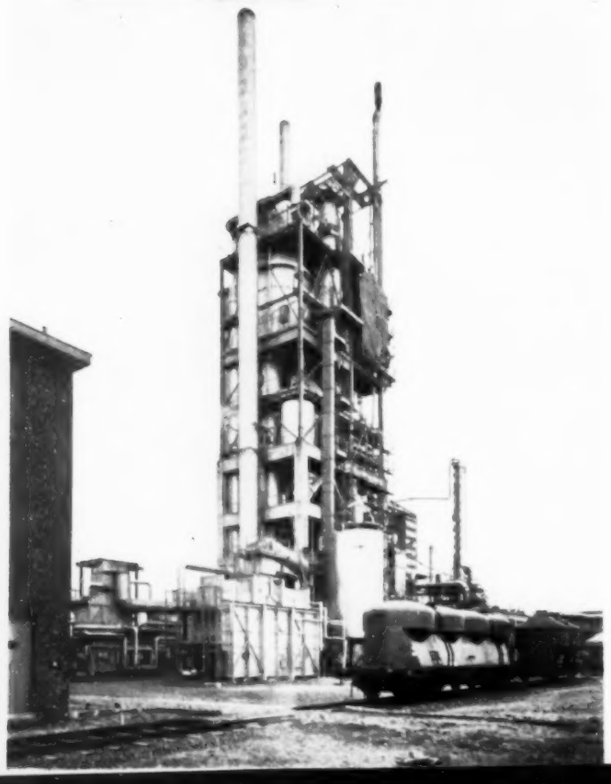
Lurgi has developed, in cooperation with Ruhrgas AG. and Farbenfabriken Bayer AG. the "sand cracker" which enables the cracking of gaseous and low-boiling liquid hydrocarbons, as well as higher boiling hydrocarbons including crudes into olefins. In the Lurgi/Ruhrgas process, heat transfer is effected by hot sand in a fluid bed, into which the feed stock is injected. The gaseous products produced during cracking are passed to a separation plant. Coke, which deposits on the surface of the sand grains, is burnt off before the sand is used again for the process. This regeneration of the sand occurs in a gas lift with the aid of preheated air and fuel oil. During this regeneration treatment, the sand is heated again before being returned to the fluid bed.

Based on research and experimental work over many years, a larger pilot plant was built for Farbenfabriken Bayer in Leverkusen. The results obtained from the operation of that plant enabled the application of the process in a large-scale plant which was installed in the new factory of Erdölchemie GmbH, Dormagen on the Rhine. This plant is capable of producing up to 20,000 metric tons of ethylene and a total of 35,000 metric tons of olefinic hydrocarbons per annum.

The process operates as follows: The feed stock, after preheating to 300-400°C, is injected together with super-heated steam into the fluid bed of the reactor filled with sand and having a temperature of 700-850°C. The hot sand heats the feed stock to the temperature required for cracking. This temperature may be closely adjusted in accordance with the type of feed stock and the output of ethylene or higher olefinic hydrocarbons, as required in each particular case. The residence time is generally between 0.3 and 0.6 seconds.

Production of Olefins in the Lurgi/Ruhrgas Sand Cracker

A large scale plant of the Lurgi-Ruhrgas sand cracker for the splitting of 200 t gasoline per day.

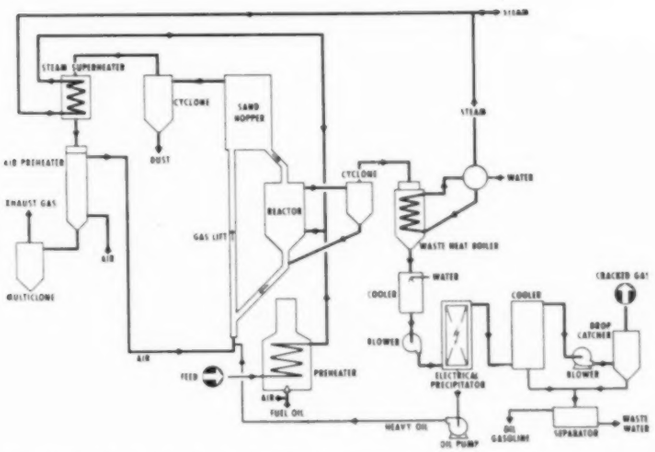


The cracked gases produced in the fluid bed, after having been freed from entrained dust in a cyclone, are cooled in a waste heat boiler and a cooler. A small quantity of heavy oil, which is produced during the process, is separated in an electrical precipitator, and used for the heating of the sand. Finally the cracked gases are cooled down to about 30°C and piped to a separation unit for the separation of the cracked products. Separation is accomplished either by low-temperature separating methods or by absorption and distillation at low-temperatures. The separation products include ethylene, propylene, C_4 olefins, aromatic hydrocarbons and tail gas essentially containing methane and hydrogen. The tail gas may be used for the production of town gas and synthesis gas or as a source of hydrogen for the hydro-refining of hydrocarbons.

The sand which has become covered with coke during the cracking reaction is continuously withdrawn from the fluid bed by means of a pneumatic gas lift to a hopper. The gas lift functions as follows: The heavy oil recovered from the cracking process is burned at the bottom of the lift with the addition of air. The resulting combustion gases, containing an excess of air, rise upwardly entraining the sand introduced at the bottom of the gas lift. The coke deposits adhering to the surface of the sand grains are burned off during the passage of the sand through the gas lift.

After separation from the uplift gas, the regenerated sand passes into a hopper from where it is continuously returned to the reactor. The gasses emanating from the gas lift, after being freed from dust in a cyclone, are utilized for the heating of the process steam and the combustion air required for the gas lift.

The sand cracker permits variation of cracking conditions within a wide range, i.e. the application of low as well as high cracking temperatures, since the coking coke occurring in the reactor does not



Flowsheet of the Lurgi-ruhrgas sand cracker.

Control room of the large scale plant.

create any problems. Accordingly, cracking conditions may be adjusted for the recovery of any desired particular types of hydrocarbons. The propylene/ethylene ratio may be varied over a range of 0.3—0.8 whereas cracking in the tube furnace permits variation of this ratio only within a comparatively small range between generally 0.9 and 1.0. The sand cracker is therefore an ideal unit for chemical works, not only because of its great adaptability to the manufacturing program of these works but also because of its great independency of other production plants, as it can handle a wide range of feed stocks.

Another advantage of the sand cracker is that it furnishes a much higher yield of ethylene than the tube furnace. When processing gasoline, the yield of ethylene is about 70-80% higher as compared to the tube furnace. In that case, the rate of the liquid byproducts is appropriately lower as compared to the tube furnace operation. The byproducts can be processed into high octane gasoline by hydrorefining treatment.

The Table includes the details of the yield and composition of the cracked gases. It will be noted that the olefin yield is highest when processing C_2-C_3-hydrocarbons and that it decreases with decreasing hydrogen content. A high cracking temperature furnishes the highest yield of ethylene, whereas with decreasing cracking temperature the yield of propylene and butylene increases accordingly.

The development of the Lurgi-Ruhrgas sand cracker has brought into being a new apparatus which makes the application of petrochemical processes largely independent of existing petroleum refineries and which offers a high selectivity with regard to feed stock. Besides, changing over from one feed stock to another is easily possible. The yield of olefinic, aromatic and other hydrocarbons may be varied within a wide range.

Table 1 — Yield and Gas Consumption when Cracking Liquid Gases, Gasoline and Crudes (one single pass).

Feed Stock	Liquid Gas				Gasoline (40 — 160°C.)								Iraq Crude					
	Ethane		Propane															
Cracking Temperature, C.	850		825		730		750		780		800		730		760		790	
Cracked Gas Output Nm3/ton of Feed Stock	1255		980		575		660		700		725		505		555		585	
Sp. Gravity kg/Nm3	0.79		1.00		1.38		1.26		1.17		1.12		1.21		1.15		1.09	
	Wt.%	Vol.%	Wt.%	Vol.%	Wt.%	Vol.%	Wt.%	Vol.%	Wt.%	Vol.%	Wt.%	Vol.%	Wt.%	Vol.%	Wt.%	Vol.%	Wt.%	Vol.%
C_2H_4	56.6	35.9	39.2	31.8	21.3	29.5	25.9	31.1	30.0	34.0	31.6	34.6	19.6	31.0	23.1	33.0	23.8	32.5
C_3H_6	2.0	0.8	12.0	6.4	15.9	14.5	15.6	12.3	12.8	9.6	12.5	9.1	12.6	13.0	12.8	12.0	10.2	9.1
C_4H_6			2.2	0.9	3.4	2.3	3.8	2.3	3.7	2.2	3.7	2.1	3.4	2.9	3.7	2.8	3.6	2.5
n-C_4H_8	1.4	0.4			4.2	2.8	3.4	2.0	2.0	1.2	1.3	0.6	2.4	1.9	0.8	0.5	0.9	0.5
i-C_4H_8			1.6	0.6	3.5	2.4	3.0	1.7	2.0	1.2	1.3	0.6	2.3	1.8	1.2	0.8	1.1	0.7
Total Olefins:	60.0	37.1	55.0	39.7	48.3	51.5	51.7	49.4	50.5	48.2	50.4	47.0	40.3	50.6	41.6	49.1	39.6	45.3
CH_4	11.9	13.2	24.0	34.3	11.6	28.3	14.1	29.9	15.5	30.8	15.7	30.8	9.6	26.8	10.8	27.3	12.0	28.8
C_2H_6	16.0	9.4	2.5	1.8	3.4	4.4	3.0	3.4	2.8	2.9	2.9	2.9	3.1	4.6	3.1	4.1	2.5	3.2
C_3H_8	0.2	0.1	6.0	3.1	0.5	0.4	0.4	0.3	0.4	0.3	0.4	0.2	0.6	0.6	0.3	0.3	0.5	0.4
C_4H_{10}			0.5	0.2	0.7	0.5	0.5	0.2	0.6	0.3	0.4	0.2	0.5	0.4	0.2	0.1	0.3	0.2
Total Paraffins:	28.1	22.7	33.0	39.4	16.2	33.6	18.0	33.8	19.3	34.3	19.4	34.1	13.8	32.4	14.4	31.8	15.3	32.6
$CO_2 + H_2S$	0.2	0.1	0.2	0.1	0.3	0.2	0.3	0.2	0.2	0.1	0.2	0.1	0.9	1.1	0.4	0.4	0.6	0.5
H_2	4.3	38.6	1.7	19.5	0.6	11.9	0.8	13.4	0.9	14.5	1.0	15.6	0.6	12.8	0.8	16.1	0.9	17.2
CO	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.4	0.6	0.3	0.4	0.4	0.6
Acetylene	1.7	1.1	0.8	0.7	0.0	0.05	0.15	0.2	0.3	0.3	0.4	0.4			0.2	0.3	0.3	0.3
Higher Acetylenes					0.1	0.05	0.25	0.2	0.4	0.3	0.5	0.3	1.3	1.5	0.5	0.4	0.7	0.7
N_2	—	0.3	—	0.3	—	2.5	—	2.6	—	2.1	—	2.3	—	1.0	—	1.5	—	2.8
Total other Gases:	6.4	40.2	2.9	20.9	1.2	14.9	1.7	16.8	2.0	17.5	2.4	18.9	3.2	17.0	2.2	19.1	2.9	22.1
Total of all Gases:	94.5	100.0	90.9	100.0	65.7	100.0	71.4	100.0	71.8	100.0	72.2	100.0	57.3	100.0	58.2	100.0	57.8	100.0
Gasoline under 200 C.	5.0	—	8.5	—	26.9	—	20.7	—	19.3	—	17.8	—	17.2	—	16.7	—	15.2	—
Oil above 200 C.	—	—	—	—	6.4	—	6.9	—	7.9	—	9.0	—	20.5	—	22.1	—	22.0	—
Carbon + Loss	0.5	—	0.6	—	1.0	—	1.0	—	1.0	—	1.0	—	5.0	—	3.0	—	5.0	—

Note: Nm3 = cubic meters measured at 0 C. and 760 mm. Hg
ton = metric ton of 1000 kilograms

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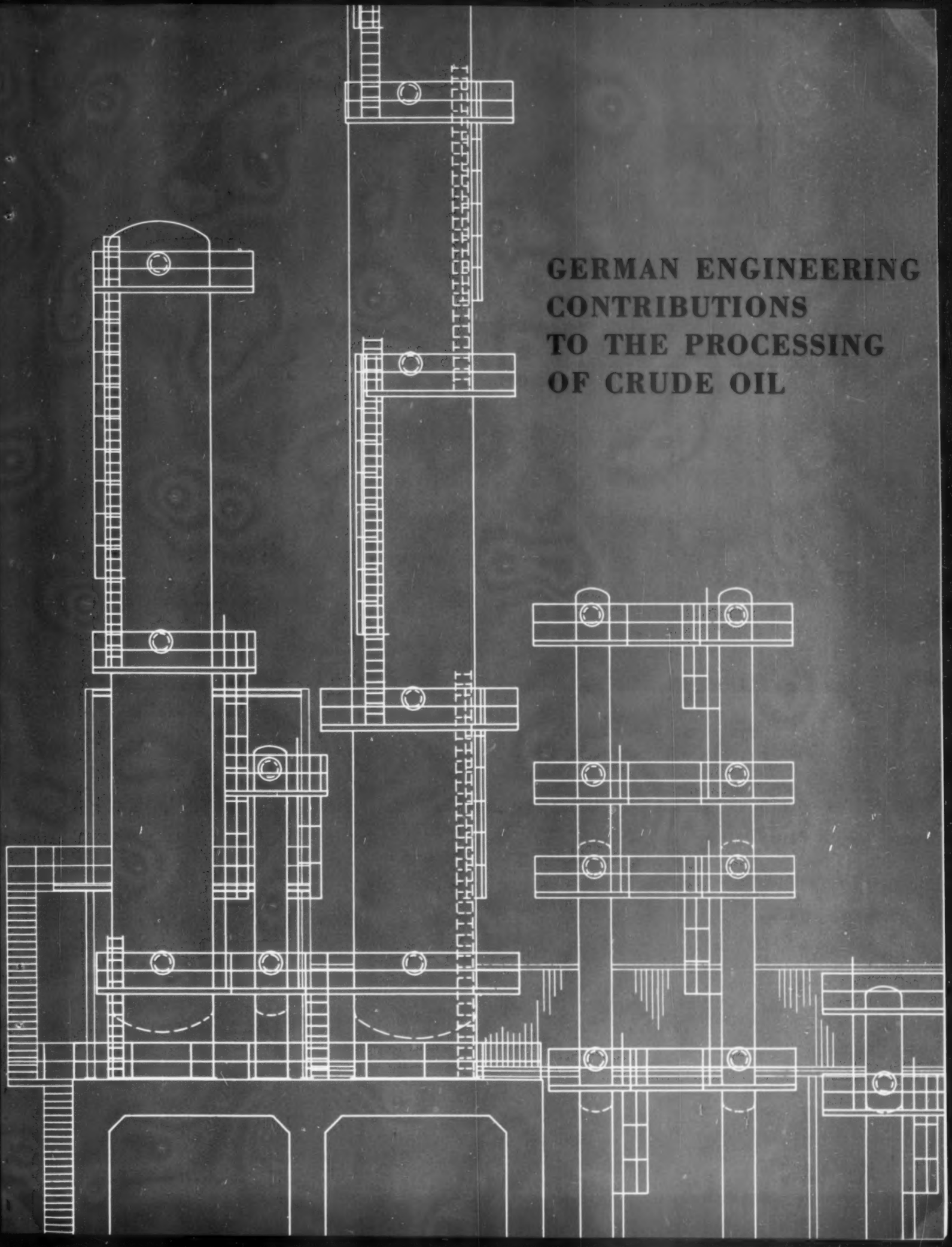
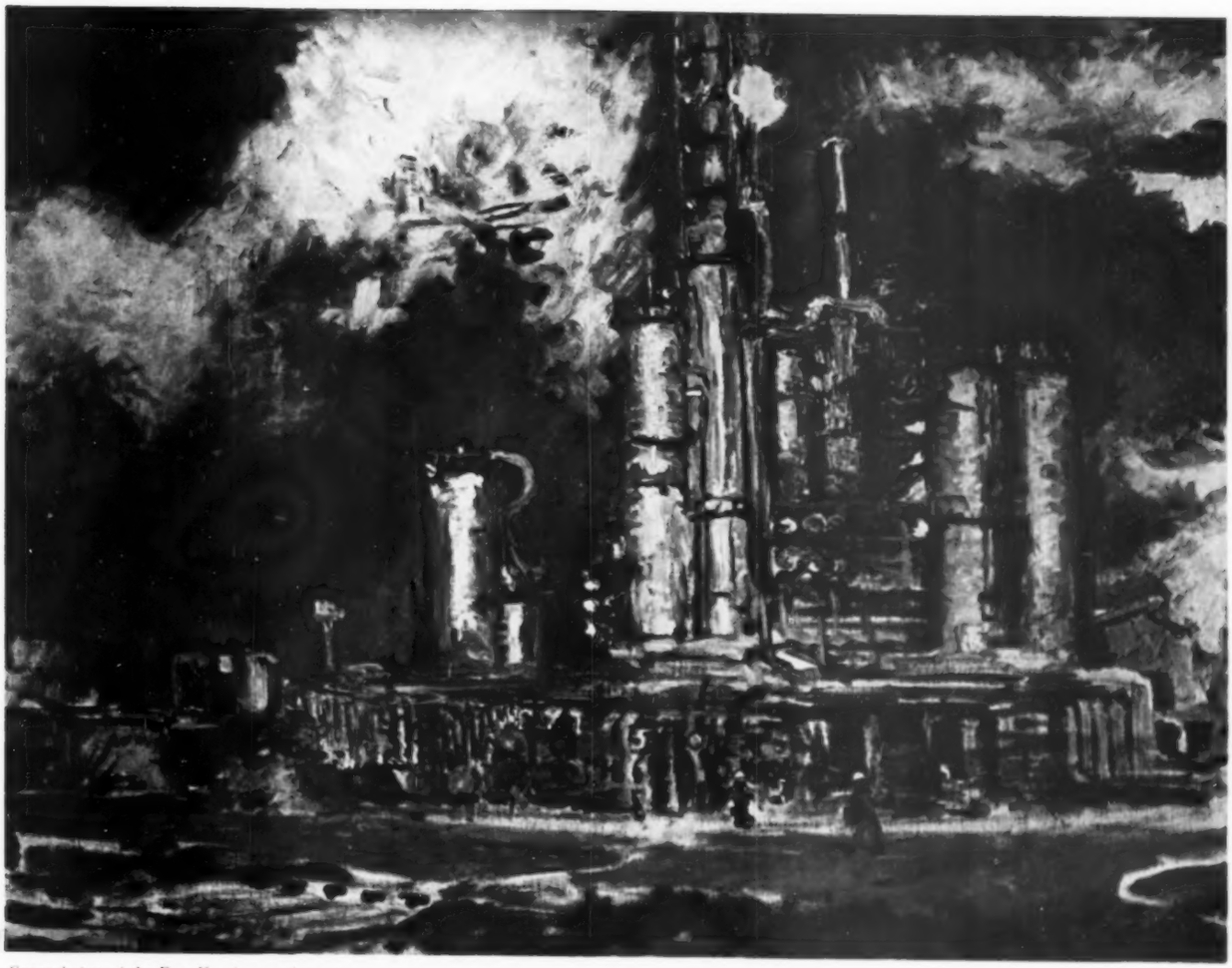
GERMAN ENGINEERING CONTRIBUTIONS TO THE PROCESSING OF CRUDE OIL





General view of the Esso Hamburg refinery
Reproduction of a painting by Professor Padua

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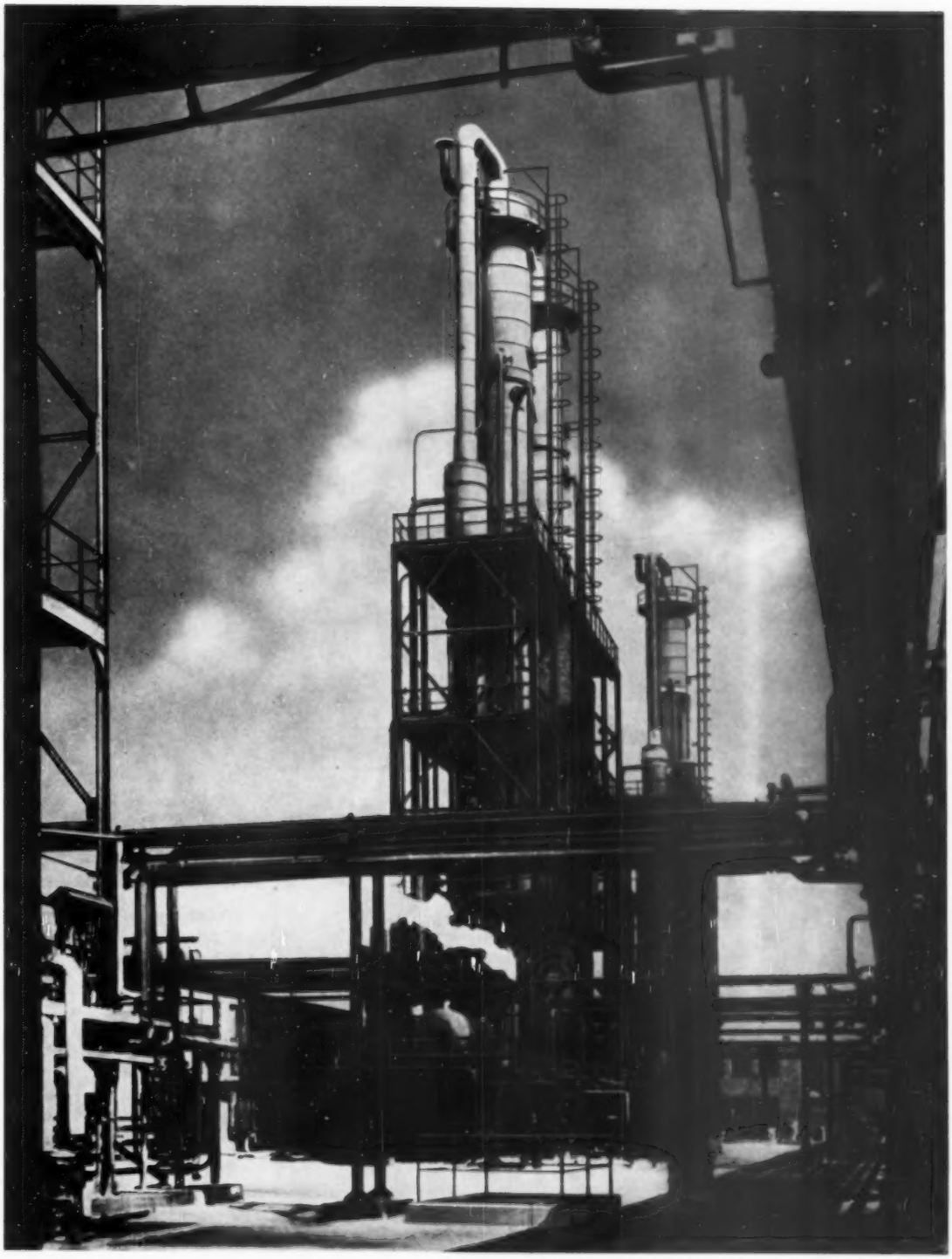
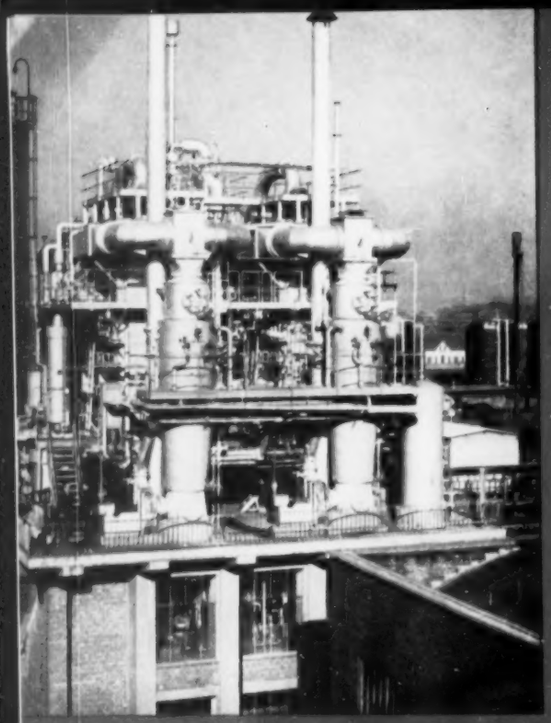
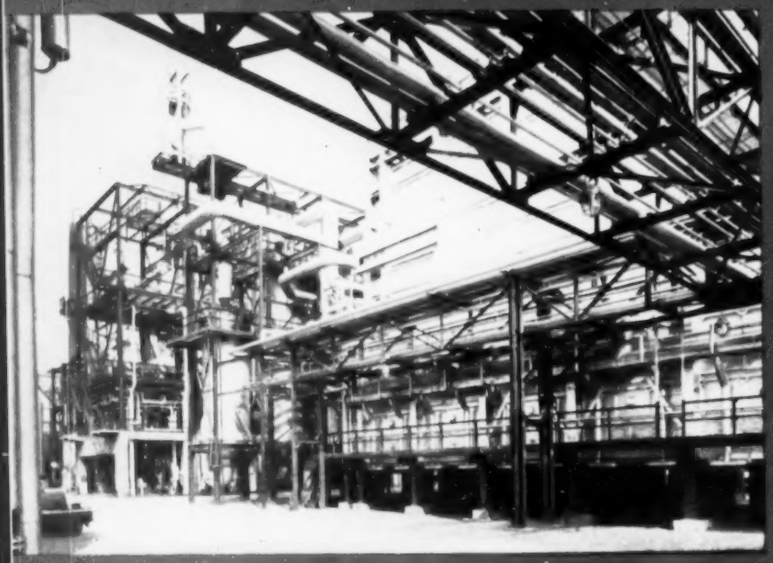
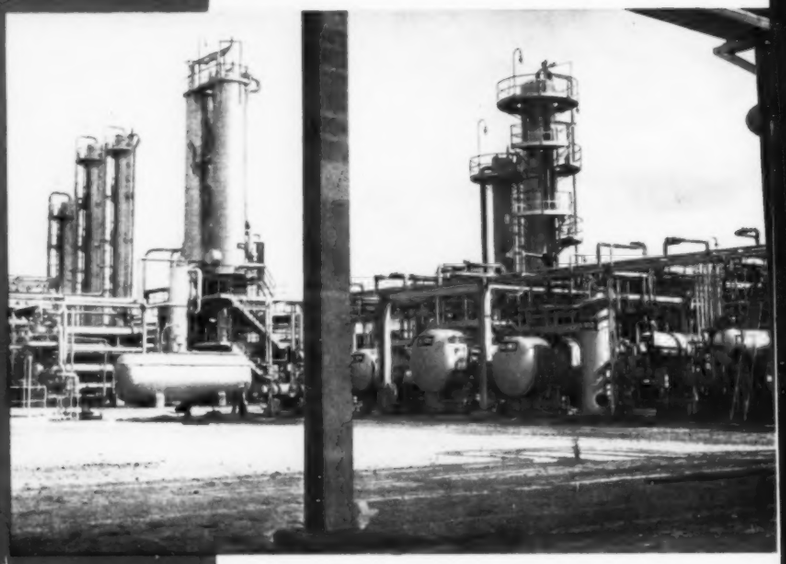




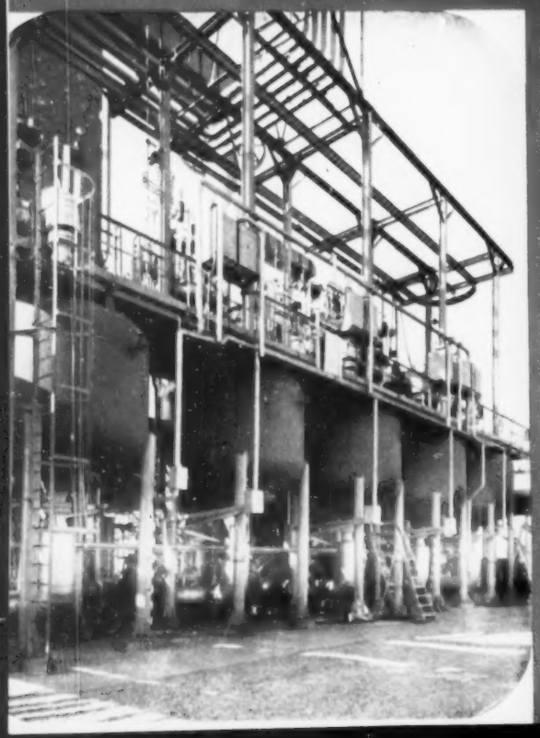
Natural gas cracking plant. Photo courtesy Dr. C. Otto & Co., GmbH, Bochum





Above left: Platforming plant. Photo courtesy Lurgi Gesellschaften, Frankfurt/Main

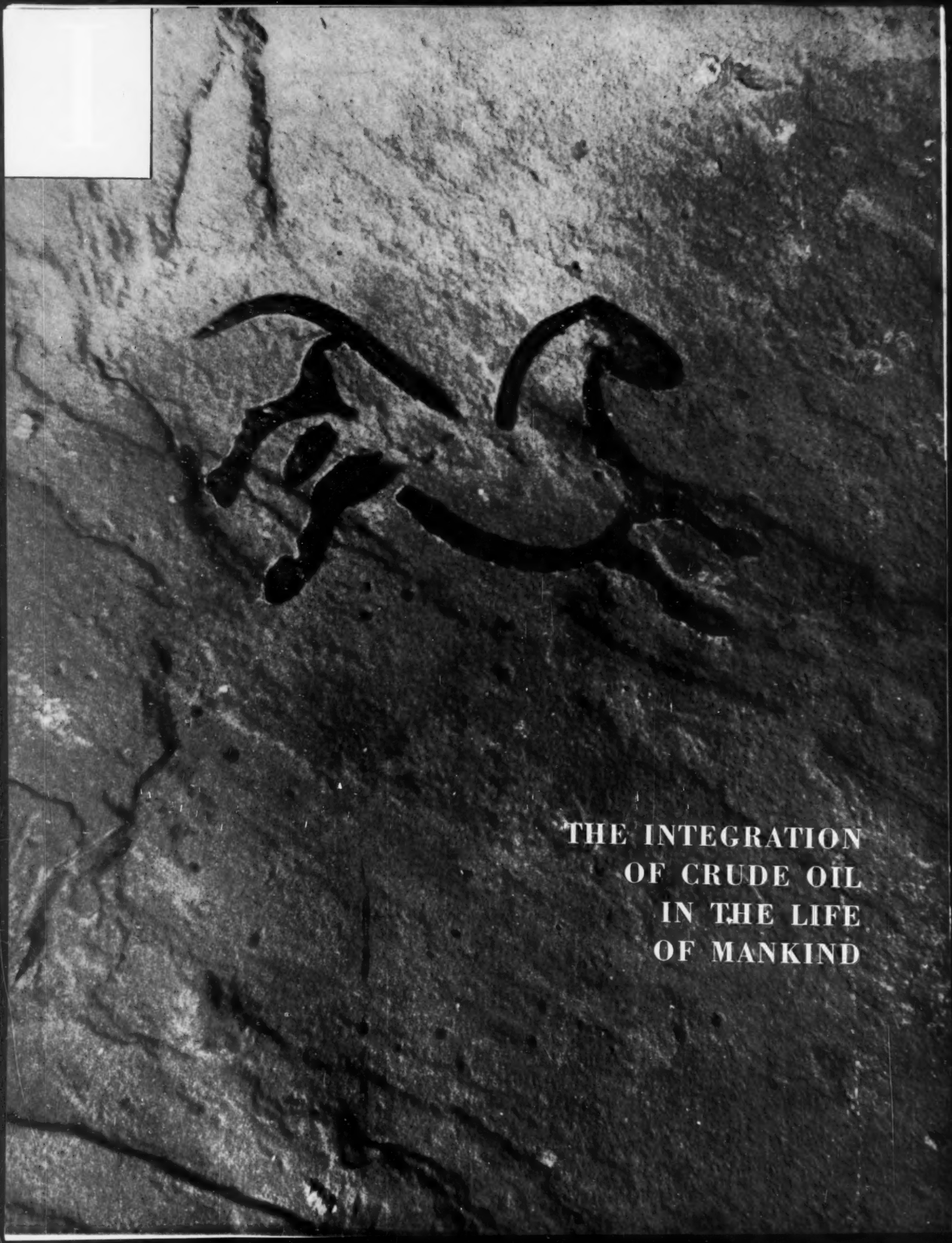
Partial view of a gas fractionating plant of a petroleum refinery. Photo courtesy Carl Still, Recklinghausen



Powerforming plant. Photo courtesy Friedrich Uhde GmbH, Dortmund

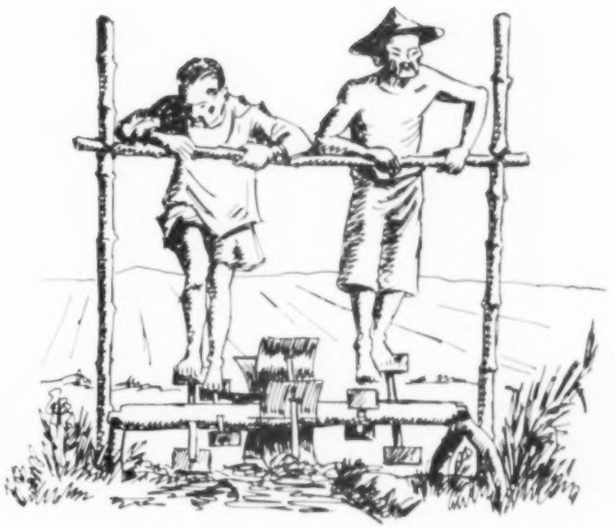
A JOINT CONTRIBUTION OF GERMAN INDUSTRY AND GERMAN ENGINEERING COMPANIES FOR DESIGN, DELIVERY AND CONSTRUCTION OF PLANTS FOR THE CRUDE OIL AND PETROCHEMICAL INDUSTRIES

EDITOR-IN-CHIEF DIPL.-ING. KARL PALZER, DORTMUND



THE INTEGRATION OF CRUDE OIL IN THE LIFE OF MANKIND

1. The integration of crude oil in the life of mankind

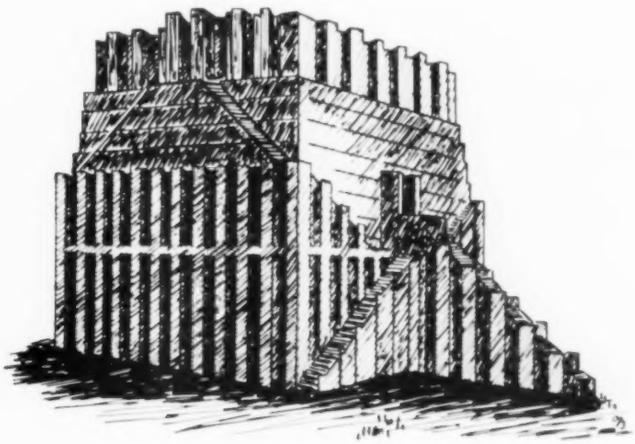


Ancient Chinese tread wheel for transferring liquids.

CRUDE oil, this liquid energy source, has already changed our economic system to a large extent, conquered narrow national economic boundaries and established the basis for a real world economy in its century-old history of industrial processing. We live at a time when we see the effects of this revolutionary "world power oil" which changes the picture of our life and gives new conceptions of space and time. Although crude oil only began to make history in the middle of the previous century, its use can be followed from obscure prehistoric times.

The historically known period of development of mankind is only relatively short when compared with the age of our planet called Earth and with the prehistoric age of mankind. Prehistoric man yearned for heat and light. Simply said, he wanted to overcome the coolness and darkness of the night which frightened him.

Without doubt it was an aim to be strived for by the human mind to satisfy the hunger for artificial heat and light. Mankind wanted to be independent of the distant sun as a source of heat and light and from the disadvantages of periodic seasonal changes. On this way from the darkness of the primitive geological times up to the present, a period covering millions of years, the efforts of the human mind were directed towards utilizing the natural treasures of the earth available since creation to make himself free of the imposed dependences, which restricted his space and scope of life.



Babylonean tower, use of mineral pitch as mortar.

Oil transportation in ox-hide containers in the Middle East in ancient times.

In this urge of the prehistoric man for having his "own" heat and light the desire to apply technique becomes evident. Technique should here be considered as the endeavors of mankind to know the natural forces, to find their laws, to utilize their possibilities and to make them subservient to mankind. As old as the history of mankind is its desire to procure continuously improved living conditions with the aid of technical development and achievements. In prehistoric times crude oil and natural gas were available to mankind and he tried to take advantage of them. At that time he could only familiarize himself with these gifts of the earth at those places where they showed up on the surface or escaped through fissures of the earth.

It is not the object of this article to review the history of crude oil which anyhow is already known to you. Only a few known data will be referred to since they represent historical landmarks in the development of petroleum to a world power. As a matter of fact crude oil was first mentioned around 1700 B.C. at which time the Chinese knew how to produce and use it. It is also known that the Japanese in 674 B.C. utilized oil which was probably stimulated by

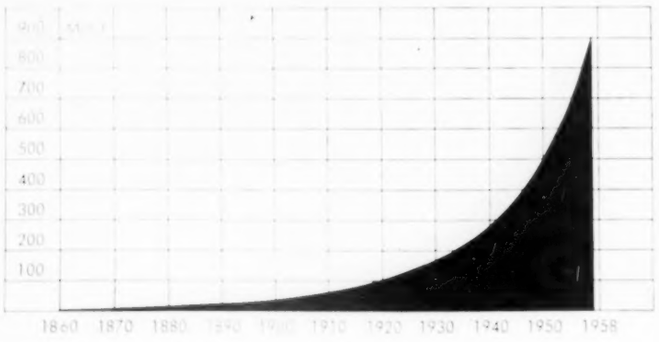
Use of bamboo pipes as petroleum pipelines in ancient China.

its use by their neighbours. Heroditus mentioned its use in 450 B.C. and later on also Plinius referred to it. In the Bible crude oil is first mentioned in the books of the Maccabees. Due to their combustibility natural gas and crude oil were first used for heating and lighting purposes and played furthermore an important part in religious worship, in the case of fire worshipping people like e.g. the Parsees. Heroditus further mentioned also that the Greeks built a temple in honor of their fire god Hephaistos on the southern coast of Asia Minor in the immediate vicinity of the so-called "Burning Rocks." The holy fires near Surachany were not only a center of religious worship but also served as a guide at night for seamen and fishermen of the Black Sea. These holy fires burned up to our time and were only extinguished in 1881.

Asphalt, pitch and bitumen, products allied with crude oil, were often mentioned in the literature of prehistoric times and had numerous applications, e.g. as a sealing medium in building works and in ships.

In all cultural eras of antiquity they were used as lubricants. The Egyptians applied them for the preparation of salves and for embalming purposes. They were used as mortar during the building of the tower of Babel. Old documents describe their use in a number of different ways, namely as incendiary war material in catapults and torches. Even in the Christian Middle Ages the use of crude oil and its derivatives is mentioned numerous times. Reports and evidence from the American continent have proven that during that same period the Incas also used crude oil in similar ways for religious worship and useful purposes.

Around 1700 B.C. crude oil was not only known to the Chinese people in the form as described above, but as a highly developed cultured nation they had recognized the necessity of a regulation of the water supply and developed technical means for complicated irrigation and drainage systems. On the basis of their technical knowledge they were able to construct water wheels, water engines, water channels and bamboo pipelines and could apply this knowledge to the exploitation and transportation of crude oil. On the other hand, Marco Polo mentions in his reports covering his travels in the Far and Near East in the latter part of the 13th century that crude oil was known as merchandise but was used only to a small extent. The transportation was carried out in ox-hide containers.



Yearly world petroleum production in millions of tons.

In Germany as early as the 15th century monks near the Tegernsee (lake Tegern) used light crude oils for therapeutic purposes.

In the 16th century Agricola reported the occurrence of natural tar, the so-called "Teerkuhlen" at Wietze, Hänigsen and Ölheim near Hanover. It was 200 years later before the initial exploitation of this tar was commenced. Still another 100 years elapsed before the Wietze oil deposits were found on the occasion of an unsuccessful search for lignite. The exploitation of this field commenced about 15 years later in 1874. In Baku crude oil has been obtained since 1700. In 1801 the Russian government declared all crude oil as valuable commercial and industrial material to be state property. The large-scale production of crude oil started in Pennsylvania in 1859 at Titusville with the drilling of the first deep well by Drake.

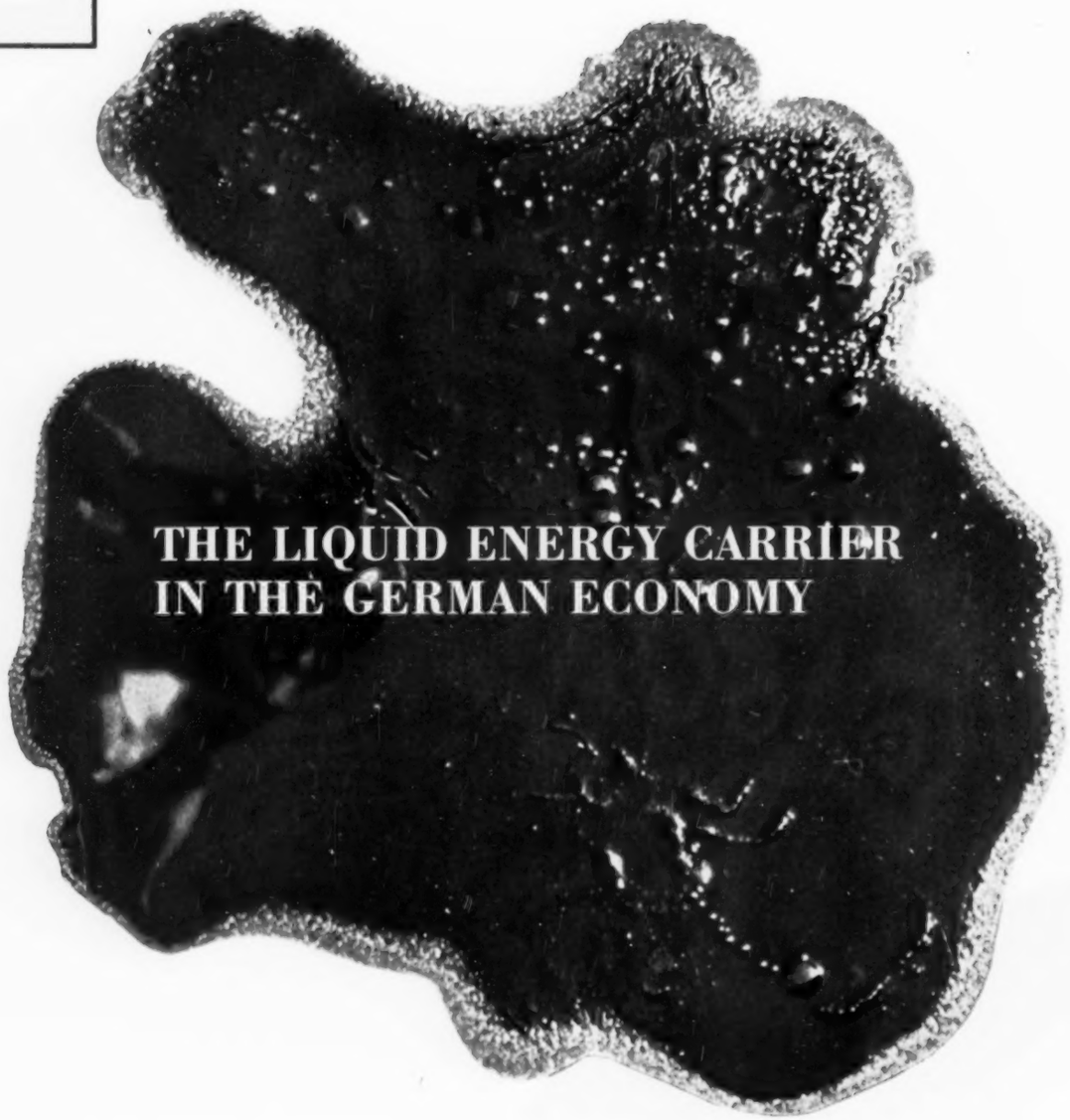
The initiation of the modern oil industry began in the second half of the 19th century. It then became clear that this gift of nature should not only be used for subordinate purposes.

It was realized that in its natural form crude oil could not find an extensive application. Research had revealed that as far as its possibilities of application were concerned the value of crude oil should be judged on the basis of the value of its individual fractions.

The result of this was that a technique of distillation and fractionation of crude oil was developed. Only after the evaluation of individual fractions had been determined was the technical foundation laid to make crude oil competitive with other fuels.

Those other fuels like e.g. lignite and coal had already for a long time proven their merits for application in industrial installations.

Heath landscape near Celle, the oldest German oil field



THE LIQUID ENERGY CARRIER IN THE GERMAN ECONOMY

A CHEMOTECHNICAL COMPETITION BETWEEN COAL AND OIL

Liquid Energy Sources

Miner in action. Photo courtesy Hoeschuerke AG., Dortmund

In particular, in Germany it was difficult for crude oil to gain industrial recognition in competition with the leading power of coal. It was, however, recognized that certain fractions of crude oil were to be preferred as liquid motor fuels whilst others had their special merits as lubricants. At the end of the 19th century crude oil in Germany was up against an industrial structure which as far as energy was concerned was monopolized by water and coal.

Table 1.

Energy sources in percentages for 1954 in USA and West Germany

	USA	West Germany
Coal	38.1%	88.6%
Water	5.7%	4.1%
Petroleum and natural gas	66.3%	7.3%

This early development of exploitation and application of coal was favored by the rigid specifications for high quality solid fuels set by the iron and steel industry in the Rhein and Ruhr. This development was also adopted by the other German coal mined districts which gradually followed the footsteps of their big brother in the Ruhr. In particular the production of highgrade coke from coal forced the German technicians to find ways and means to utilize the by-products of the coke oven plant in an economical and efficient way for industrial purposes. In the early years of the technical era the coal industry rapidly became an economic power.

Table 2.

Origin of petroleum and petroleum products consumed in Germany in %

	Germany				West Germany	
	1910	1920	1930	1938	1954	1958
German synthetic oils	9.8	12.8	24	27.1	16.75	8.3
German petroleum	15.7	2.9	3	7.8	31.2	20.9
Imported petroleum and finished products	74.5	84.3	73	65.1	52.65	70.8

Although the new competitor, crude oil, could not be used for all applications, coal was to supplement crude oil. Since the chemical relationship of the hydrocarbons in crude oil and coal was at that time a recognized fact it was only a matter of intensive research to convert coal by means of suitable processes into liquid motor fuels. Just like the benzene obtained from the coke oven plant had rapidly found a ready market as liquid motor fuel, it was planned to conquer the whole field of liquid motor fuels with synthetic products obtained by means of coal liquefaction.

German engineers and chemists investigated and worked out the basic data for an autarchic synthetic oil industry and coal chemistry which in the 20th century reached a large capacity. The apparently inexhaustible source of manpower which in the early part of the 20th century was available in Europe for the coal mining districts and the tendency towards a self sufficient economy with customs and market protection favored this predominance of coal in the German economic area.

Science and research directed their efforts almost exclusively to coal liquefaction.

Aside from the processing of the indigenous crude oil which at that time was obtained in only small quantities the total liquid motor fuel requirement was supposed to be covered by coal.

Actually there are three processes which aimed at the production of liquid motor fuels, liquid lubricants and liquid fuels from indigenous coal, namely:

The carbonization and coking process.
The high pressure hydrogenation process (Bergius and Pier).
The Fischer-Tropsch process.

The various processing steps of coal liquefaction and the motor fuel synthesis radically changed the character of the German equipment and machine construction in the 1920's.

The large size industrial units, high operating pressures and very high temperatures required a complete reorganization on the part of supplying companies. The engineering offices and engineering science were called upon to carry out orders with which the rapid development of the chemical equipment and machine manufacture in the time after the first world war could hardly keep pace. This had its effect even on steel production, steel refining and processing, machine tool shops, transportation techniques and on all branches

Table 3.

Yearly production of liquid and motor fuels from coal in Germany in 1944

	Tons
Motor fuels	3,000,000
Diesel fuels	950,000
Lubricating oils	60,000
Fuel oils	1,000,000
Byproducts	250,000

Steel mill worker. Photo courtesy Hoeschwerke Ag., Dortmund

of the German supply industry. An industrial expansion to an unthought of extent took hold of the whole of the German industry.

The economic results of this expansion, modernization and investment in all branches of the industry could be obtained only in this short span of time in the closed cycle of a self sufficient industrial country.

This technical development and the industrialization of the whole of a nation in less than 20 years had to be digested and shaped by the German people in the hard school of life during the second world war and the postwar years in order to fit the German way of life and its political economy again into the newly reorganized world of the postwar era.

During this period of technical development the demand for liquid motor fuels arose as a categorical imperative in all industrial countries. All countries which did not have domestic sources or were not able to find these liquid motor fuels in their own country had to endure violent shocks to their economic life and their national economy. Unfortunately in Germany domestic crude oil production did not keep pace with the steadily increasing motorization, so that in the early part of the 20th century German motor cars depended almost exclusively on the importation of foreign motor fuels.

Although German oil drilling technique was already recognized in the early days of international exploration all attempts to intensify this exploration in Germany failed. This condition still existed in the early years after the second world war and it was only after 1950 that crude oil and natural gas were found in appreciable quantities which led to an important increase in German production. At that time the large foreign exchange requirement for the importation of motor fuels were no longer bearable from the viewpoint of the national economy.

Perhaps, the immense coal reserves in the Ruhr district which on the basis of the present exploitation would suffice for more than 1000 years and the numerous lignite reserves enough for many hundreds of years retarded geological initiative in Germany and made the German industrialist and his chemists and engineers place too much stock in the liquefaction of coal hydrocarbons.

Coal

Although various processes for the synthetic production of liquid motor fuels from coal yielded in the beginning only small amounts of gasoline and diesel oil and undesirable amounts of by-products, within a few years science and research were able to overcome these disadvantages. The cracking of hydrocarbons under high pressure and or high temperature made it possible to obtain by means of these new processes all those fractions from hydrogen to heavy fuel oil that are found in crude oil and natural gas.

Most of the processing steps of petrochemistry and coal chemistry differ only in so far as the derivatives of the hydrocarbons to be processed do not originate from crude oil but from coal.

The development of modern crude oil processing in countries with

Refinery operators. Photo courtesy Esso Ag., Hamburg

extensive indigenous oil fields like the USA and Russia and in those countries like Britain and the Netherlands possessing colonies rich in oil took place along smoother lines. Since the natural fractions of crude oil obtained by means of distillation and fractionation did not meet market requirements it was early recognized that other ways had to be followed so methods were developed to improve quality and create numerous special products.

Also in the case of crude oil the application of cracking of hydrocarbons was unavoidable for reasons of economy and marketability. As far as the presently applied processes are concerned there is not much difference now between those from crude oil processing and those of the motor fuel synthesis. As a result chemists and engineers nowadays are faced with practically the same technical problems in crude oil refining and motor fuel synthesis.

Looking at it from the chemotechnical side the competition between crude oil and coal required the same ability on the part of chemist and engineer in both fields. Success in one field induced greater effort in the other. This holds good also in the field of equipment manufacture with regard to the working out of new designs and the application of new materials, in the steel industry with regard to improve alloys and higher strength of special steels and last not least for the chemotechnique with regard to the application of steadily improved catalysts for the conversion of hydrocarbons. Contrary to this, the economic conditions of this competition were unequal.

Customs protection, efforts to attain self sufficiency because of the irregular international foreign exchange situation, the advantage of the older and well established large organizations gave the synthetic oil industry a competitive advantage in Germany at least up to the end of the second world war. Conditions after the second world war brought about extensive changes in the structure of the world economy and at the same time a considerable scarcity of coal.

After a coordination of the world markets a natural price gap between crude oil and coal became evident and proved to be definitely in favor of oil as far as the competition between the liquid energy sources was concerned. The sale of synthetic oil products which unavoidably are obtained as by-products of the coking and carbonization plants could only be justified and was only possible by exerting all efforts to manufacture products of improved quality, to obtain optimum process yields and an appreciable reduction in the cost of manufacture.

Direct production of synthetic oil products from coal is nowadays only possible in those countries where coal can be obtained so cheaply that its price justifies conversion of the hydrocarbons to liquid fuels. This is only possible in a few exceptional cases. Furthermore, the competition in Europe between crude oil and coal recently involved large energy consumers. This competition between fuel oil and solid combustibles may be considered as one of the keenest and most drastic contests in the field of energy; furthermore it has developed at a time when a new competitor has appeared at the threshold of the atomic era.

CRUDE OIL AT THE BEGINNING
OF THE ATOMIC ERA

Design of a nuclear plant. Courtesy Babcock-Werke, Oberhausen.

3. Petroleum at the beginning of the atomic era

It was already stated that the competition between crude oil and all other combustibles as energy sources may be considered as one of the most decisive developments of the last 15 years.

In the USA petroleum supplies nearly 70% of the energy requirement. The other industrial countries of the western hemisphere and in particular the industrial countries of western Europe follow in rapid succession. Crude oil which is easily transported can readily be made available in all markets and at all places of consumption to meet the steadily increasing energy demand. Although crude oil and its fractions can be offered economically in any world market, it should not be overlooked that tankers and pipelines constitute nerve cords of the energy supply which jeopardize in an incalculable way not only our industry, but also our whole life in case of political or warlike events.

In western Europe and in particular in Germany the consumption of fuel obtained from crude oil is steadily increasing, although at all times coal was the preferred energy source. Whereas in 1938 crude oil supplied about 7.5% of the German market, this percentage had increased in 1958 to 13.5%. Indications are that this percentage will be considerably higher within the next few years, a prediction based on more than just the statistical data of the oil industry.

Even on the basis of these predictions the oil industry cannot make definite provisions as was recently shown by the situation in the European coal markets. In addition thereto many unfavorable prognoses with regard to the lifetime of the oil fields in the western hemisphere have been published. It cannot be definitely stated as to how far oil occurrence in the eastern hemisphere is exactly known and to what extent it will be fully exploited in future years. There is no doubt that the possibility of early exploitation exists.

Russia probably will not be agreeable to offering its oil to western consumers or refiners only against foreign exchange. The danger exists however that some day hoarded amounts of oil will be dumped by the Soviet Block on western markets to unsettle and upset the western oil economy. It is, therefore, quite logical that in view of these circumstances science and research are exerting all their efforts to develop the newest energy source, atomic energy to a point where it can be used economically. This triumvirate: coal, crude oil and atomic energy can be looked upon with confidence by energy generating centers to assure future expansion. Just as at the close of the coal era there did not follow an exclusive oil era, there will certainly not come an era in which atomic energy will have a monopoly. It stands, therefore, to reason that as far as crude oil is concerned exploitation and processing facilities should be enlarged, but that this expansion should be correlated in a reasonable manner with the other energy sources.

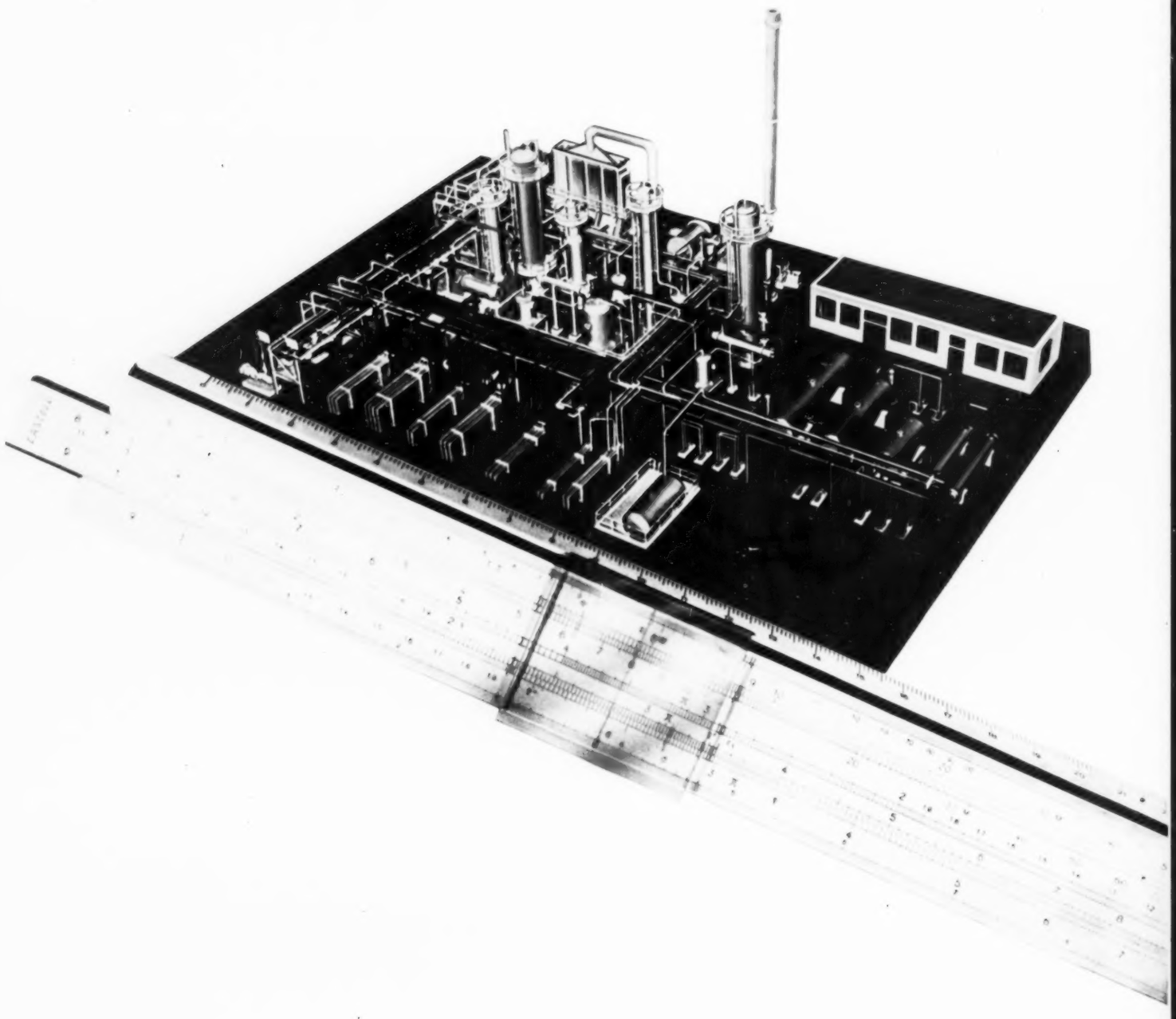
Coal and crude oil are not only energy sources but also suppliers of appreciable amounts of raw material for the chemical, plastic and textile industries so that the use of these gifts of nature for generating energy only cannot be tolerated. Modern refineries will be more and more laid out for supplying raw materials to the petrochemical industries. The conversion of hydrocarbons now is carried in modern processes which enable the use of various crude oil derivatives in a well balanced way for both energy and chemical purposes.

When nuclear energy is used to close the energy gaps existing throughout the world, crude oil will be the only energy source which can be used for this purpose since coal has become too cumbersome and expensive for the world economy. A use of crude oil exclusively as fuel would deprive the future economy of a raw material without which the chemical, plastic, textile and the consumer-goods industries cannot provide the future living standards required by our descendants.

In view of the possibilities of generating energy by means of nuclear fission crude oil will become more highly evaluated and will require an increased application of modern techniques.

The utilization of crude oil as raw material for chemistry will involve technical problems to be solved by future chemists and engineers. The application of modern conversion processes in oil refineries of a rather recent date and our technical era requires from mankind enormous future progress in order to fulfill the eternal mission: "Subdue the earth and have dominion over it."

THE ENGINEER AND HIS PROFESSION



4

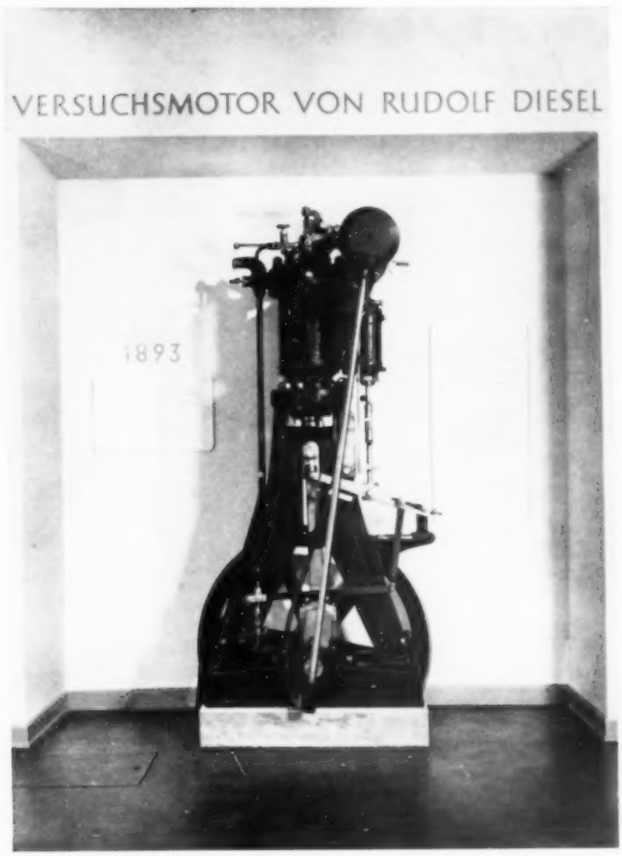
The engineer and his profession

Horseman in Bamberg (Bavaria) cathedral.

ON preceding pages a description of petroleum and its use from prehistoric times up to the present has been given; we, born in the era of scientific progress, now stand at the beginning of the atomic era or at the threshold of the era of the universe. It was previously mentioned that the object of the application of technology was to subdue the earth which mission is as old as the history of mankind itself.

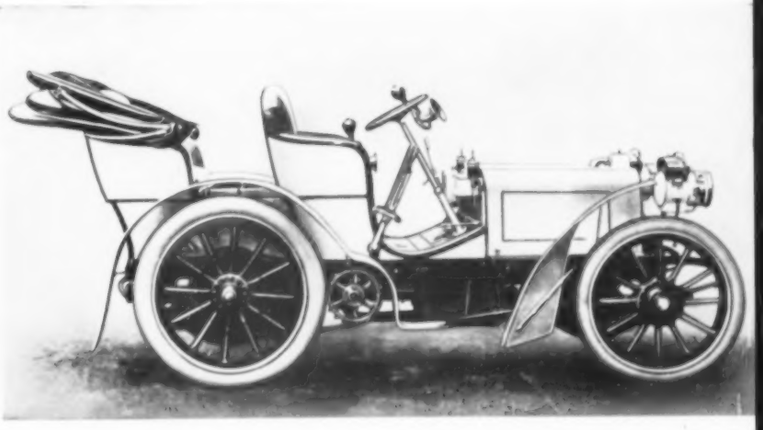
Tools, weapons and jewelry constitute the first evidence of the application of technology by mankind. Shelters, pots and fabrics and

First Diesel motor. Photo courtesy Maschinenfabrik Augsburg-Nürnberg Gustavsburg.



Magdeburg hemispheres for Otto von Guericke's vacuum experiment.

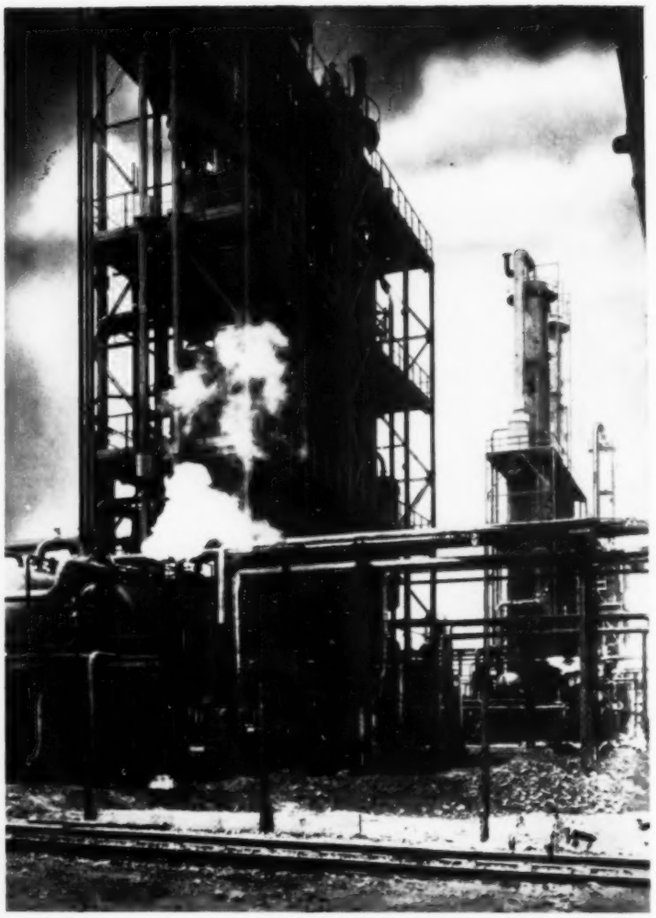
First Daimler Benz motor car. Photo courtesy Daimler Benz AG., Stuttgart.



objects of art date from a later period. The building of fortifications and towns, of enormous temples and tombs, of irrigation and drainage systems, of transportation facilities and war equipment is reported from the times of the Babylonians, the Persians, the Egyptians and the Chinese. In antiquity the Greeks in particular adopted these achievements of prehistoric times from many nations. Their scientists looked for and formulated many laws which maintained their validity up to the present time. The enormous dimensions of their universal empire enabled the Romans in turn to bring this knowledge of the natural sciences to the western people. Since prehistoric times the technician provided mankind with improved tools, new everyday household appliances, agricultural implements, superior weapons and war materials, means of transportation, mechanical aids and machines, more beautiful jewelry and better clothing in more useful shapes and of better technical execution. Many books would have to be filled to hand down to posterity the evidence of the earliest human creative power and ability.

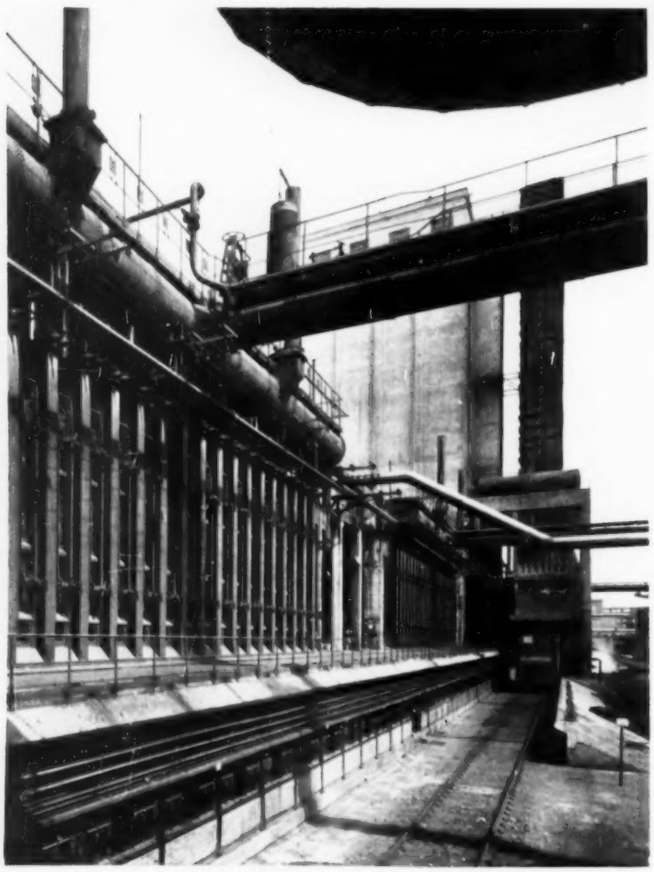
Although up to Galileo's time the development of technology proceeded more along manual and empirical lines these great deeds could only be accomplished with the aid of the individual ingenuity of men: the old Romans used the word "ingenium" to designate the natural abilities of mankind which allowed him to apply the natural sciences.

In the Middle Ages there were not only a large number of skilled craftsmen and artists, but also an appreciable number of outstanding technicians who achieved great individual performances. By reason of the fact that these men were at the same time artists and scientists, the Middle Ages brought about an increased teaching and studying of the human sciences which in turn advanced the dissemination and the application of the modern natural sciences. The all-round engineer of the Middle Ages was the pioneer of the era of technology. His ability and his performances still shed a light upon the many years during which the technical development apparently had come to a standstill.



Crude oil distillation plant with atmospheric and vacuum towers. Photo courtesy Friedrich Uhde GmbH, Dortmund.

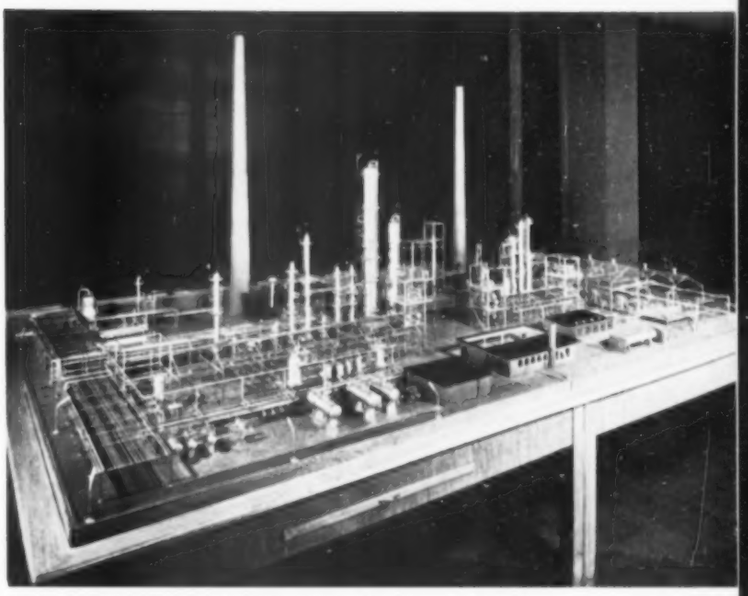
Coke oven plant. Photo courtesy Dr. C. Otto & Co. GmbH, Bochum.



It was not until the 19th century that the systematic promotion of the natural sciences and in particular their application made it possible for the era of technology to be initiated. Scientists and searchers of the modern natural sciences became engineers. It was during this time that the term engineer began to designate a profession characterizing a gifted man trained in natural sciences, applying the recognized basic laws of nature for the progress of mankind. This era not only brought about the most violent development in technology but also introduced scientific research into all branches of the natural sciences. The immortal creations of engineers from the Middle Ages up to the beginning of the era of technology demonstrate as landmarks and symbols the successes and triumphs of a technique towering above all other eras. The more technology was applied to the various aspects of human life the more the individual branches of the natural sciences became specialized.

The rapid development of industrial chemistry during the latter part of the 19th and the early part of the 20th century placed before engineers problems of quite a different nature. Prior to that period the application of the natural sciences and, therefore, also the development of technology served the purpose of replacing manpower, to bring mankind light and heat, the necessary implements, machines and equipment for providing a more comfortable and better life, to safeguard nutrition with the aid of economic transportation means and to enable exchange of goods over vast areas, in a word, to serve those tasks which require the services of a specialist in a restricted working sphere. As a consequence the engineer specialized in a

particular field replaced the all-round engineer. However, also technology had further advanced. Natural raw materials no longer met requirements as far as purity, lifetime, properties, economy and cheapness were concerned. The rather simple processing of raw materials and wasteful methods of shaping conventional materials stopped the development of the progressing technology. The call was heard for replacement of natural raw and basic materials which were qualitatively inadequate and quantitatively insufficient. This was the hour of birth of modern industrial chemistry which took the lead in the research field. The successful application of molecular conversion in the chemical industry and of the first industrial size synthesis processes followed shortly. Man had subdued the natural forces, he was able to improve the quality of the natural materials and to form new materials at will. However, more than ever the chemist as researcher required the indispensable assistance of the engineer enabling him to apply the discovered material conversions and chemical processes worked out in laboratory scale to large-size industrial plants. The results of specialization in technology now became noticeable. The diversity and multiplicity of the modern processes



Model of a refinery now under construction. Photo courtesy Friedrich Uhde GmbH, Dortmund.

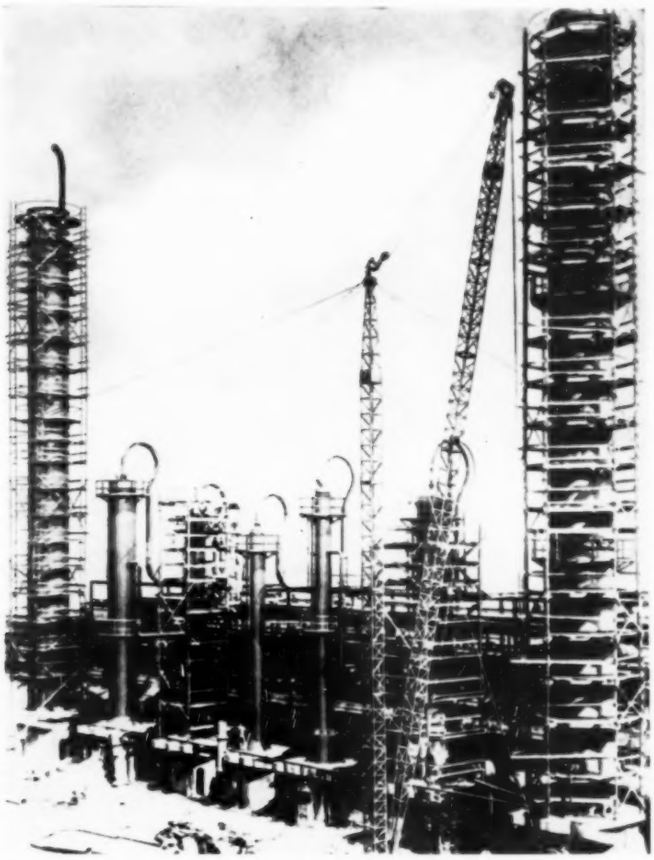
required the use of all branches of the natural sciences and consequently the services of specialized engineers versed in thermodynamics, construction engineering, in hydraulics and energy generation, in dynamics and physics, electrical engineers, statisticians, geologists and metallurgists, designers and process engineers and construction engineers. For one job many of these specialists were required.

The design of a large chemical plant required more than ever the teamwork between chemist and engineer, between research and execution, between design and operation, between producer and supplier. Only in this way could the enormous industrial chemical plants be developed forming in themselves real cities and communities of a special kind. Due to the fascinating nature of these large industrial plants technology attracted men. The essential character of the work, the regular working hours and the results of modern teamwork created new vocational concepts for working men. The teamwork of the modern plant displaced individualists of early days and put in his place the enterprising spirit of teamwork.

It was at such a period in man's development that petroleum began its historical existence.

This liquid raw material reached a predominant position in a much shorter time than its predecessor. Qualified engineers and chemists were available in the early days of its application. These men made crude oil not only one of the supporting pillars of the power industry and to the most mobile and universal fuel for motors, but also the supplier of raw materials for the chemical industry in general and for the plastic industry in particular thus giving the industry a bright prospect for the future.

Molecular conversion and synthetic processing of crude oil and its fractions open immense possibilities for its development and future.

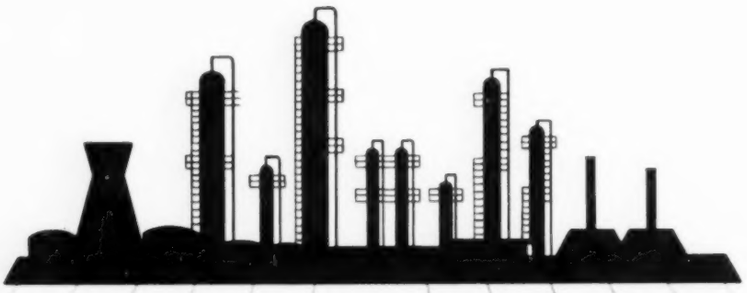


Gasoline and gas fractionators of an alkylate plant. Photo courtesy Friedrich Uhde GmbH, Dortmund.

General view of a Fischer-Tropsch plant. Photo courtesy Lurgi Gesellschaften, Frankfurt Main.

V

THE BUILDING OF PLANTS FOR THE CRUDE OIL AND PETROCHEMICAL INDUSTRIES, A TEAM-WORK OF DESIGNER AND SUPPLIER



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PLANTS

The building of plants for crude oil and petrochemical industries — a teamwork of designer and supplier

Refinery under construction. Photo courtesy Friedrich Uhde GmbH, Dortmund

THE preceding chapters reviewed the history of crude oil, its influence and its relation to the German economic area. The relation of the reciprocal connections and dependencies between crude material and men was pointed out.

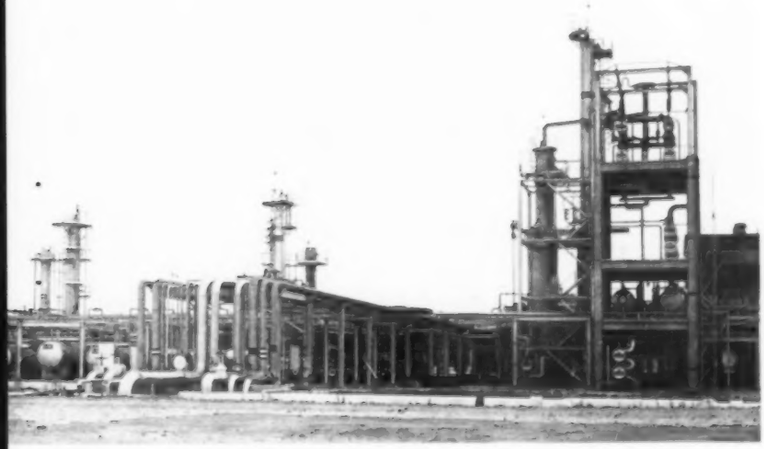
A short consideration led us to the men who as engineers and chemists, as scientists and technicians fully stand in the sphere of influence of and render their services for technical progress and higher future living standards for mankind. We looked at the economic area of the German people and its high degree of industrialization. Sixty years ago at the turn of the century practically only finished and half-finished products were manufactured in the German economic area. Our industrial products were exported for which there was a great demand on the international market. German workmanship and its certificate of origin "Made in Germany" were recognized and were the best salesmen for our exports. From an international standpoint there were only a few industrial countries and in overcrowded areas the desire to become an industrial society slumbered like Sleeping Beauty. The first world war shook the international economic life and destroyed for years the possibility of regular exchange of goods.

Due to modern techniques of ship building and the economic strategy of war, oceans became theatres of operation in world war I. The international exchange of goods came to a complete standstill. Countries without their own industry and, therefore, without their own production suddenly found themselves without many necessaries of life.

From 1914 industrial planning in Germany was completely focused inland and on increases in its own production; this situation radically changed after 1920. The world at large did not want goods from the industrial countries but rather manufacturing plants to safeguard themselves against the consequences of a future sea war. Due to the long war, the international money markets were, however, chaotic and underdeveloped nations did not control adequate capital except in exceptional cases.

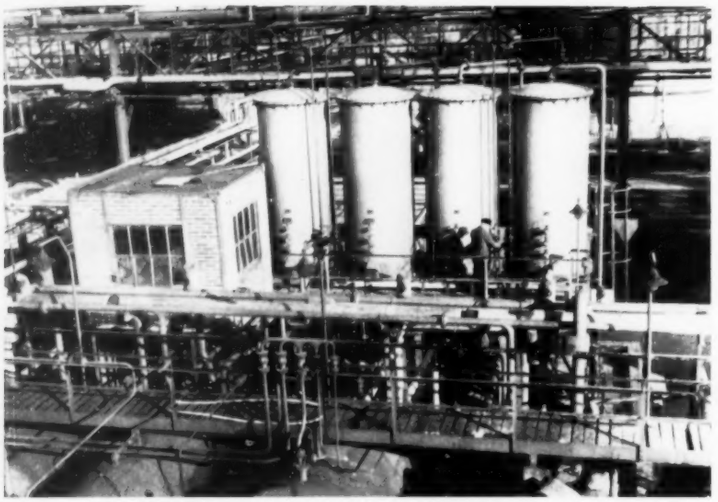
Industrialization of many countries was not actually stopped because of these circumstances although temporarily postponed. The clash of arms of the first world war had shown many countries how helpless they were without their own armament industry. Consequently much of the investment in postwar years was spent in an uneconomical way for the armament industry. In the middle of the twenties quite a different course was chosen and investments were made in the iron and steel industries and the base and chemical industries. In this period German engineering companies participated for the first time to a larger extent in the international competition. Notwithstanding the appreciable lead especially of the American and British companies German engineering companies succeeded with remarkable speed in getting a foothold in this field. However, often times business was rendered more difficult not on account of the competition from abroad but mostly due to economic short sightedness at home. It was argued that foreign building was an economic sellout, a breakdown of our own exports on account of the industrialization of foreign countries and an enormous amount of resistance had to be overcome. For the engineering companies and the foreign customers, the big German production companies were the proprietors and licensors of interesting processes and the possessors of know how. Under no conditions were they willing to lose their traditional exports of finished products.

Partial view of a gas fractionating plant with treating facilities for LPG and gasoline. Photo courtesy Carl Still, Recklinghausen



With the beginning of the crisis around 1930 opinions changed and the export of plants and installations became regarded as an important future for the German export. With regard to world markets the German supplier industry took a back seat since the engineering companies of other countries naturally favored and employed their own suppliers for the building of plants and installations. The successes of foreign competitors and consequences of the sales crisis at home which resulted in an army of a million of unemployed called for a close cooperation between German engineering companies and German suppliers which more than ever in the thirties depended on each other for their existence. The first results of this cooperation was a new wave of autarchy which abruptly destroyed this development. The industrialization of Germany which was to a large extent falsely directed and overdimensioned began in the years of 1934 and 1935 and destroyed much what had been accomplished for the benefit of German industry in the preceding years.

Although the desired autarchy of Germany in the synthetic raw material sector apparently led to poor investments, this violent in-



Gasoline treating plant. Photo courtesy Pintsch Bamag AG, Butzbach

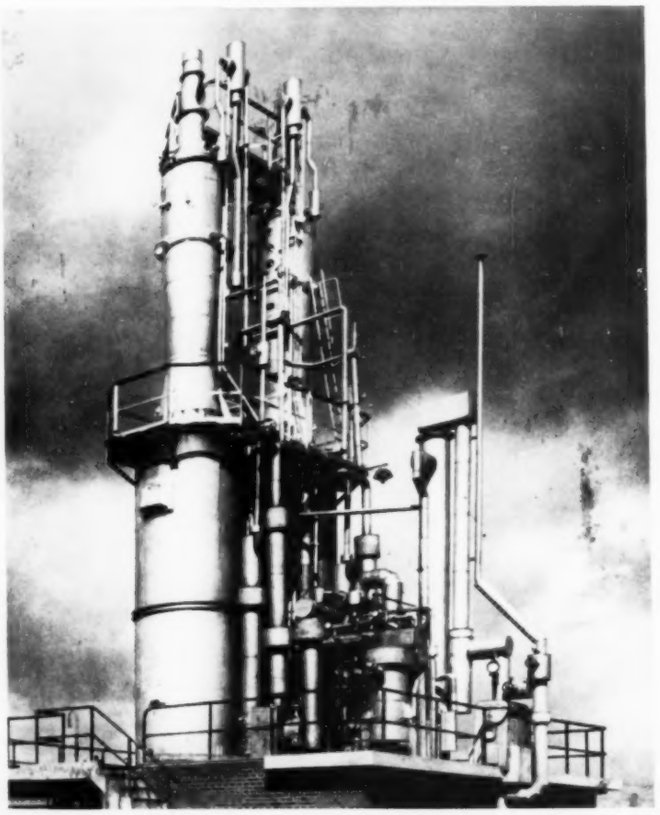
dustrial development also had its good points. The large volume of orders calling for high quality products requiring the utmost of technical skill forced the supplier industry to modernize its manufacturing facilities, to improve the quality of its products and at the same time to materially increase the potential of its production.

The flow of men to technical vocations increased from year to year as a steadily increasing number of young Germans decided to go in for the manual and intellectual branches of technology. This increase of the German industrial potential and the larger number of technically skilled people in particular in the supplier industry proved to be of great advantage to the German export economy after the second world war. In addition thereto we owe further great successes in the postwar period to the proficiency of the German engineer and chemist.

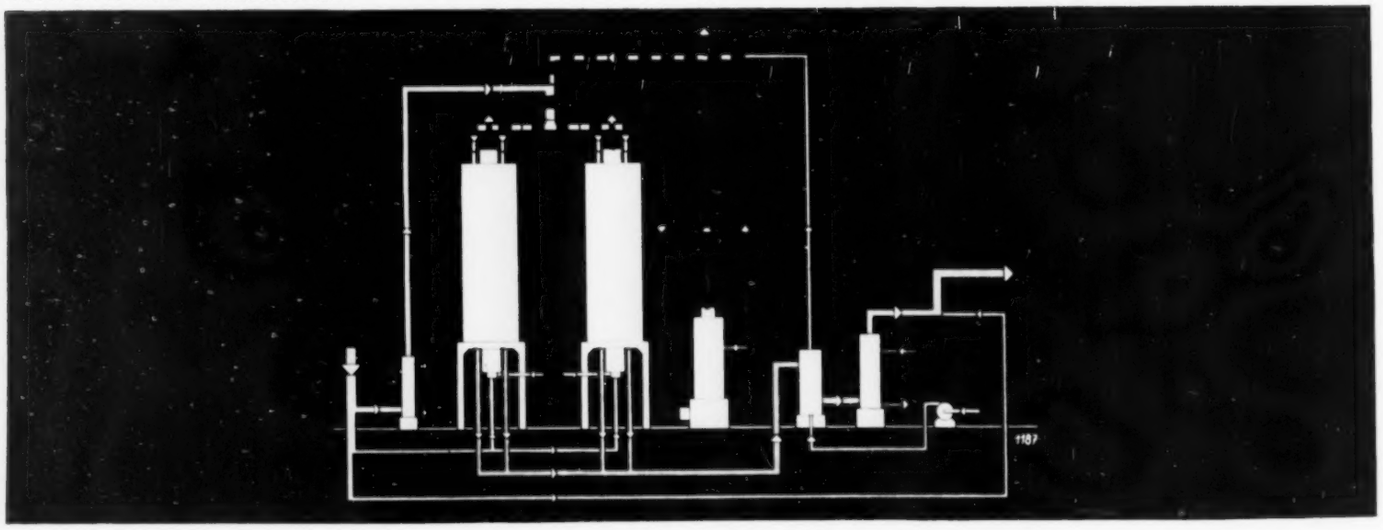
Many plants originally built to promote the autarchy of the German raw material economy and the processes used therein could, thanks to the sound scientific training of the German technician, in a comparatively short time be modified to the manufacture of those products which met the requirements of domestic as well as foreign postwar markets. Consequently, the expansion of the German oil industry in these years found a fully equipped supply industry which was able to cope with all problems and orders placed in connection with the rapid advance of the use of petroleum in the German economy. The amount of crude oil produced in Germany which noticeably increased after 1950 and the rapidly increasing amount of crude oil from foreign sources required to cover the demand of the German market could to an appreciable extent be processed and refined in available installations. Hydrogenation and synthesis plants were converted to modern refineries which were eminently suited both as to process and to equipment for the molecular conversion of crude oil hydrocarbons.

Thus, heavy oils and heavy residual oils could be converted by hydrogenation to middle and light oils. Products obtained in this way were remarkably rich in hydrogen and, therefore, particularly suitable as charging stock for modern cracking processes. In existing production plants the various fractions could be obtained from crude

Catalytic natural gas cracking plant. Photo courtesy Dr. C. Otto & Co. GmbH, Bochum



Process diagram of a catalytic natural gas cracking plant courtesy Dr. C. Otto & Co. GmbH, Bochum



oil as formerly from coal liquefaction in a quantity and quality as required and suitable to be used as charging stock for the petrochemical industry. In this way a large industrial potential in Germany which originally was destined for other purposes could be used for the crude oil processing in addition to the existing and modernized refinery potential.

During this reconstruction and modernization of existing refineries the excellent cooperation between German engineering companies and the supplier industry proved to be very valuable. The value of this teamwork was also proven during recent years in connection with numerous new refinery construction projects. In this respect the supplier industry showed that it was able to cope with all requirements for the processing of crude oil.

In other European countries and in particular in western Europe a similar increase in crude oil processing capacity took place. For this building program German engineering companies and perhaps still more German suppliers were called on to participate to a large extent. Nowadays, the same tendency of enlargement of oil processing capacity can be observed in countries adjoining the European economic area; this tendency is of special interest for German engineering companies and suppliers.

In particular the areas in southeastern Europe, North Africa, in the Near and Middle East require outside aid for the building of crude oil processing facilities since their own technicians are not yet in a position to design, to manufacture, to construct and to start up such large-size production units. In view of their scientific training, their knowledge of operating such large production plants and their personal qualifications and their willingness to serve in foreign countries the German chemists and engineers are particularly suited to give these countries any desired assistance in the field of oil processing. This German technical knowledge is naturally not only available to the European economic areas and their immediate neighbors but also to practically all countries of the world as was again shown in a recognized way in the last twenty years.

Due to the proven and successful cooperation between engineering companies and suppliers the German industry is in a position to successfully participate in any technical and economic competition throughout the world with regard to industrialization plans. In recognition of the importance of this teamwork also German authorities endeavor to give any possible economic assistance to countries having such investment plans to the best of their ability and under the rules of a free unrestricted market.

Thus far not all of the German embassies and consulates have an advisory engineer for economic affairs in their staff; however, the German engineering companies are strongly favoring the appointment of such an advisor for all German embassies and consulates.

In order to provide for good coordination between foreign investment plans and German manufacturers those German companies interested in foreign business have carried on continuous market studies enabling them to participate early in economic and technical planning so that the best possible promotion of future German export volume is guaranteed.

Numerous illustrations in the preceding chapters give the reader an idea of the work and the successes of German engineering companies in crude oil processing and of related branches such as petrochemistry, the plastic industry, gas processing and by-products processing industries. These illustrations clearly demonstrate the complexity of the problems and the severe rquirements to be met by chemist and engineer for the planning and building of plants for the refining and petrochemical industries.

German engineering training always has been aimed at giving the young engineer an extensive and broad knowledge of the "Verein Deutscher Ingenieure" (VDI = Society of German Engineers). This society is more than 100 years old. Its aim is to serve the scientific progress of German technology and the vocational interests of the German engineer. Since the VDI embodies all German engineers without any branch or professional classification a significant activity of this society is given special recognition in this section "German engineering contributions to the processing of crude oil" by quoting the following creed of the engineer:

CREED OF THE ENGINEER

"In his professional activities the engineer shall have respect for the unknown and humility in his attitude toward the Omnipotence who rules his terrestrial life.

"The engineer shall place his professional work in the service of mankind and maintain in his profession the same principles of honor, justice and impartiality for all people.

"The engineer shall respect the dignity of human life and render services to his fellow-men irrespective of birth, social standing and philosophy of life.

"The engineer shall not submit to those who disregard human rights and misuse the nature of technology; he shall be a faithful collaborator for human civilization and culture.

"The engineer shall always endeavor to cooperate with his Colleagues in the intelligent development of technology; he shall esteem their activity as he wants others to respect his.

"The engineer shall place the honor of his profession above economic advantage; he shall strive for the respect and the recognition of his profession due him by alll classes of people."

(Continued on page 256)

Gas purification and scrubbing. Photo courtesy Pintsch Bamag AG, Butzbach

1

Engineering companies for designing and building complete plants

Conference and exhibition room

PAPERS and journals report almost every day about proposed new construction projects and extensions of industrial plants throughout the world. In some way or other these notices about the type and amount of the products to be manufactured and about the size of the investments have some bearing on petroleum. They all involve:

Petroleum as liquid energy, as motor fuel for stationary and mobile engines and for heating purposes.

Petroleum as raw material or its fractions as charging stock for the chemical, petrochemical and plastic manufacturing plants.

Petroleum as liquid fuel for gasification plants, for the generation of synthesis and combustible gases.

Petroleum as lubricant for all moving parts.

Technical-minded people at the threhold of the second half of the 20th century often fail to realize the manifold presence of petroleum in our daily life. It is impossible to describe in a few words the influence of petroleum and its products on our present life and economic area. Just a look at the highly developed process techniques of crude oil processing shows the problems and requirements with which the oil technician is faced in connection with industrial operations.

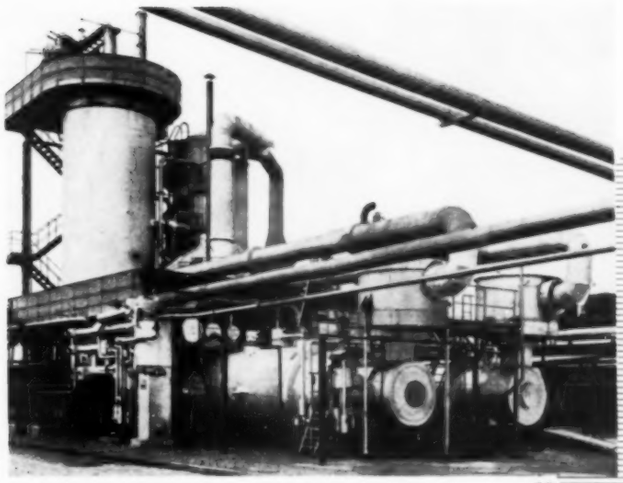
Without claiming completeness the most important processes and process steps with which the chemist and the engineer charged with the planning of crude oil processing units must be familiar from a material as well as from a technical standpoint:

Crude oil degassing.
Desalting and dehydration of crude oil.
Preheating, heating and evaporation of crude oil and its fractions.
Distillation and fraction under atmospheric and elevated pressures or under vacuum.
Gas recovery, gas purification, gas absorption.
Gas fractionation and gas cracking.
Re-distillation and stabilization of fractionated products.
Molecular conversion of hydrocarbons by means of thermal and catalytic processes: Reforming — Hydroforming — Platforming — Powerforming — Visbreaking — Splitting — Cracking — Hydrogenation — Dehydrogenation — Isomerization — Polymerization — Alkylation.
Sulfur removal through extraction and hydrofining.
Sulfur recovery and production of sulfuric acid.
treatment of motor fuels and lubricants.
Product improvement by adding TEL, additives and detergents.
Solvent extraction.
Deasphalting and dewaxing.
Asphalt production and blowing of asphalt.
Production of petroleum coke.
Synthetic lubricating oils.
Production of fats.
Waste oil recovery plants.
LPG and pressure plants.
Natural gas cracking plants.
Oil gasification plants.
Atomic fission for the crude oil processing.

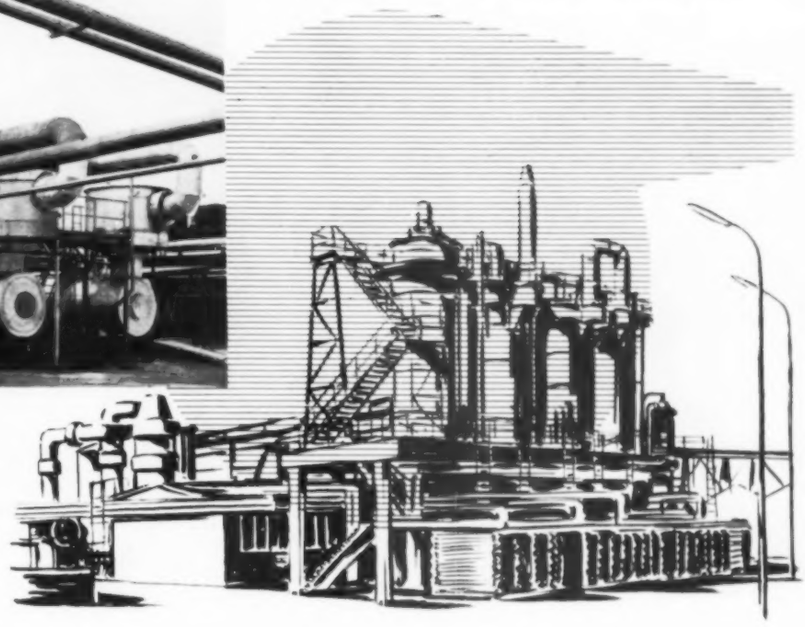
Increasing requirements of the consumer for better and more suitable quality, the market demand for larger quantities, the progressive industrialization of the national economy and last but not least, the urge to obtain products in the most modern and scientific way in the immediate vicinity of the market have called for new construction, extension and modernization of petroleum manufacturing plants. These problems are carefully analyzed by government and economic authorities who are steadily carrying out sys-

Office room

Drawing room



Plant for treatment of hydrogen sulphide to sulphuric acid



We are constructors of plants for petroleum industries:
manufacture of pure sulphuric acid from waste acid
manufacture of sulphuric acid from hydrogen sulphide

OUR PROGRAM:
roasting of ores
sulphuric acid
sulphur dioxide in
gaseous and liquid state
alkali sulphates
soda ash-caustic soda
phthalic anhydride
polymer phosphates
and related industries

chemiebau

Dr. A. Zieren GmbH · Cologne · Germany

tematic market research in national and international economic areas.

In this way domestic requirements can be guaranteed for years to come and a long range plan set up with regard to the export and exchange possibilities for the supply and opening up of foreign economic areas. The results of these investigations constitute the basis on which extensions and new construction are carried out. The plant owner outlines his wishes with regard to the product to be obtained and charges a consulting engineer or an engineering company with the development of his plans since in view of the complexity of the projects it is impossible for him to maintain the large staff of specialists and skilled personnel required for carrying out such work. It is, therefore, absolutely essential that an engineering company handle these special problems.

German engineering companies deal with these problems in all continents and in practically all countries of the world. Proposals for such plants and installations are prepared by process engineers and designers in close cooperation and based on the results of extensive research work and operating experience of many years. Before a proposal is prepared local and national conditions have to be studied. For that reason contact between engineers and the customer is made in early stages of the project. This contact is extended as work progresses and reaches its maximum during the carrying out of field work and starting-up of the plant since during these periods a large number of engineers and erectors are in direct contact with the customer's engineers and operators.

When visiting a foreign city or country such industrial installations are due to their nature and location less evident than impressive bridges, theatres or skyscrapers. In Germany as well as abroad and perhaps more so there than here industrial development takes place in special sections of a town and many industries are compelled by their raw materials to build plants in isolated areas far from large cities. For that reason the world traveller needs a sharp eye to locate some industrial installations.

However, when successful, he will be astonished to note the extent to which German engineers are active in all countries of the world and in that advertise the German economy. Since large sums are always involved in these projects (often many millions of dollars) this fact may be considered as an indication of how much responsibility and confidence is placed in German engineering companies.

After the preliminary clarification of economic conditions for the building of a new refinery or petrochemical plant the local conditions on which technical planning is to be based will have to be investigated and agreed upon with the customer:

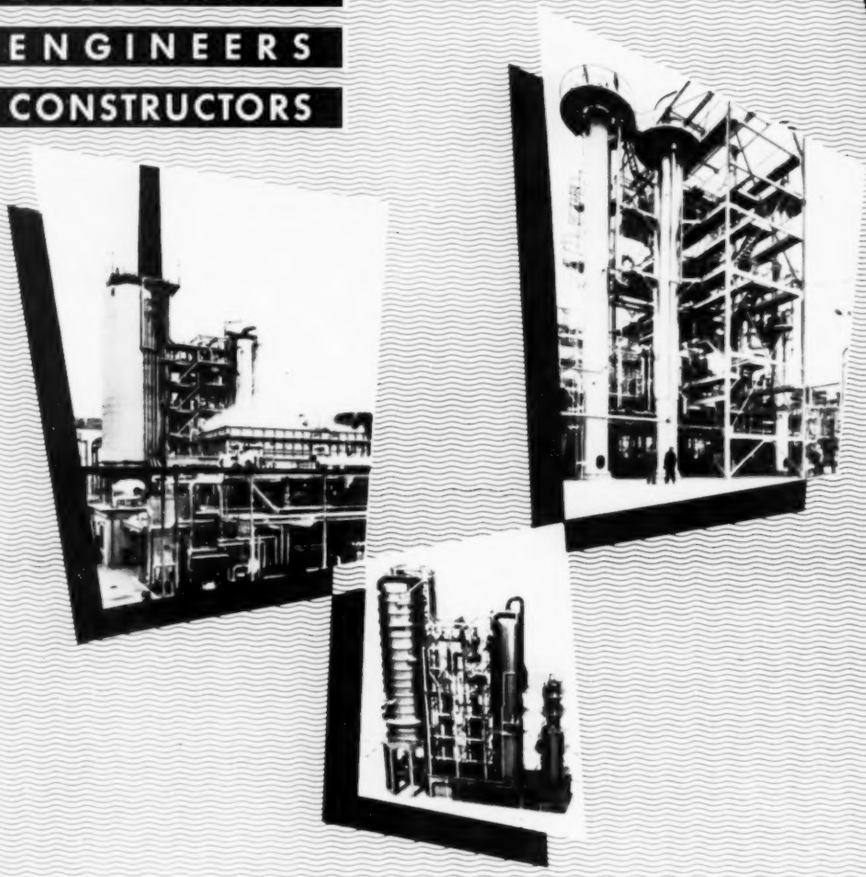
Selection of the building site.

Soil conditions and site area.

Secretary's room

CONSULTANTS
DESIGNERS
ENGINEERS
CONSTRUCTORS

LOOS

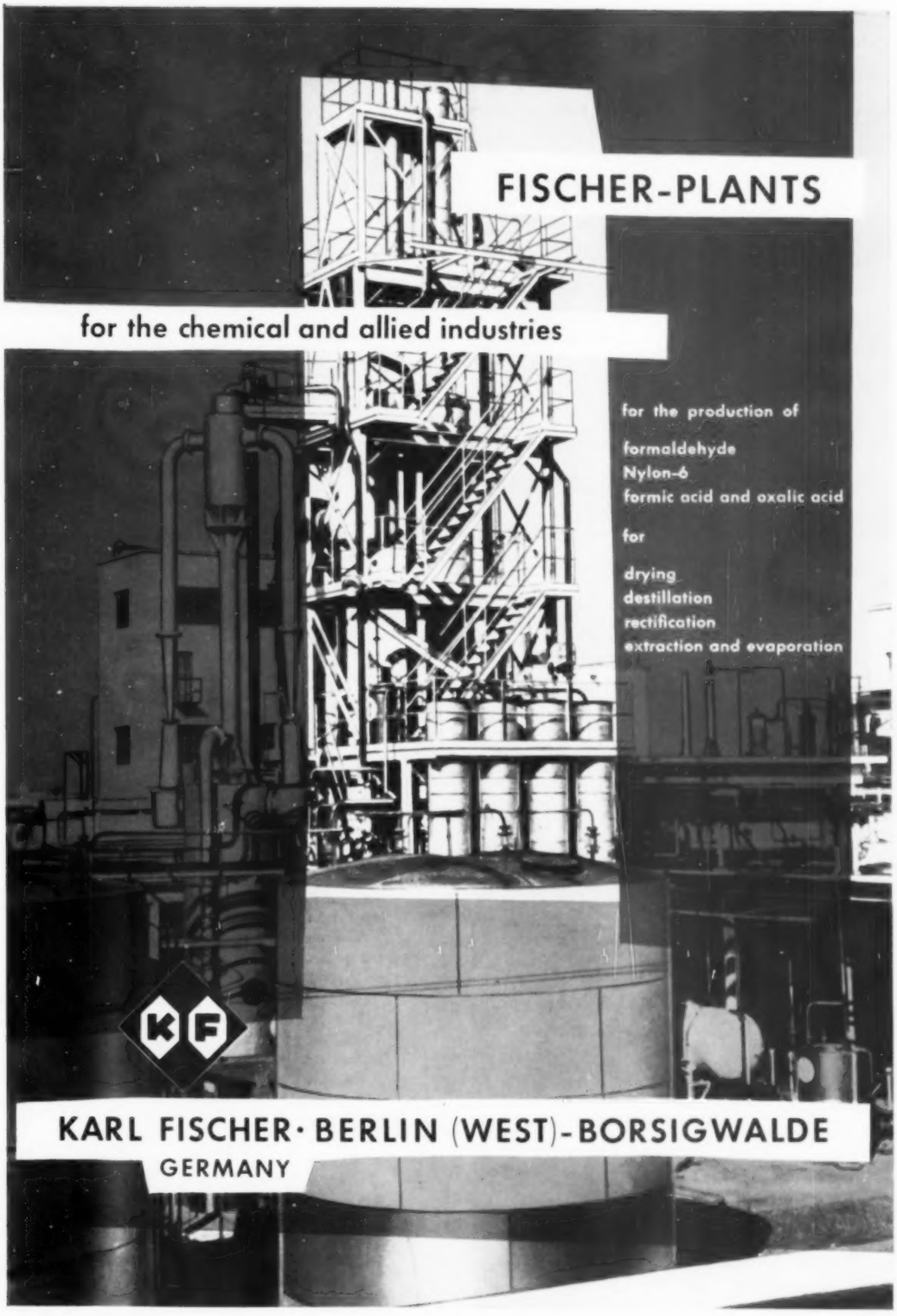


For nearly 50 years EDELEANU GESELLSCHAFT M.B.H. has gained wide experience in solving problems of the oil industry. It is known all over the world for the SO_2 Solvent Extraction of Kerosin and Gas Oil and has up to this day designed and built more than 70 commercial plants. Still to day the SO_2 Solvent Extraction plays an important part in the processing of petroleum and gains a new field in the production of pure aromatics.

The EDELEANU GESELLSCHAFT M.B.H. was once established to commercially utilize the SO_2 Extraction Process. It developed Dewaxing and Deoiling Processes with solvents and urea. EDELEANU became a well known engineering company, a helper in solving all technical problems connected with the processing of petroleum.

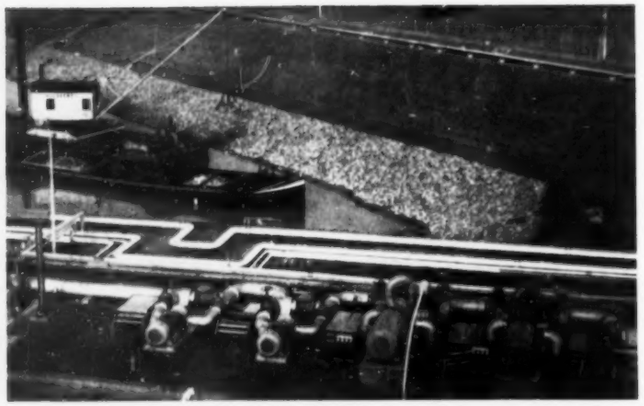
FRANKFURT A.M. · OPERNPLATZ 2 · GERMANY

EDELEANU


FISCHER-PLANTS
for the chemical and allied industries
for the production of
formaldehyde
Nylon-6
formic acid and oxalic acid
for
drying
destillation
rectification
extraction and evaporation
KF
KARL FISCHER · BERLIN (WEST)-BORSIGWALDE
GERMANY

F. H. KOCKS K. G. CONSULTING ENGINEERS

36, FRIEDRICH-EBERT-RING • KOBLENZ • GERMANY



- **PIPELINES**
- **BOOSTER STATIONS**
- **TANKFARMS**
- **CIVIL ENGINEERING FOR REFINERIES**
- **BARGE FACILITIES**

OTHER FIELDS OF ACTIVITIES:

Hydraulics, Municipal Engineering, Roads, Railways, Air Ports, Buildings, Town planning, Structural Engineering

OUTDOOR PIPE LINE PUMPING STATION designed for the Gelsenberg-Benzin A.G.

Outdoor pipe line pumping stations for crude oil and motor fuels are generally housed in enclosed buildings in which motors, pumps and control panel are located in separate rooms in view of the explosion hazard. Thus it should not be possible that air circulates between the various rooms. The rooms are to be provided with adequate mechanical ventilation designed according to special specifications. *The construction and operating cost* for such pumping stations is *very high*.

Today pumps and explosionproof electric motors can be supplied in weatherproof construction.

In case no other protection is required, outdoor pumping stations are preferred on account of the saving of expenses. In outdoor pumping stations the formation of explosive air mixtures is not possible.

The pictures show the *pipe line outdoor pumping station* near Wesel designed by *F.K. Kocks K.G., Consulting Engineers, Koblenz*, for a transloading installation for the Gelsenberg-Benzin A.G. This type of pumping station is the first of its kind in Germany. It was designed for crude oil of the highest danger class and was taken into operation in December 1957.

The pumping station consists of 2 sets of pumps, each of which comprises an *electrically driven booster and high pressure pump* delivered by the Deutsche Worthington GmbH, Hamburg. One set of these pumps serves as stand-by.

The *control panel* is located about 200 m (about 650 ft.) away from the pumping station. Here all operations are indicated and automatically controlled. These operations can also be controlled by hand. All electrical switch gears are combined in one station which is located away from the explosion endangered area.

The present pumping station has a *capacity of 620 cbm/h (3900 bbls./h)*. and transfers crude oil through a pipe line of 47 km (29 miles) to the Gelsenkirchen Refinery.

In case 2 high pressure pumps are used, the *capacity* increases to *860 cbm/h (5400 bbls./h)*.

When designing the jetty, variations in the water level of 10.0 m (about 33.3 ft.) had to be taken into consideration. The pumps located on the floats which transfer the crude oil from the tankers via a flowmeter to intermediate storage tanks were delivered by the Amag-Hilpert Pegnitzhütte AG, Nuremberg.

Generally oil separating plants are built in accordance with API specifications. In the particular case of the Esso Cologne Refinery

OIL SEPARATING PLANT

designed for the Esso Cologne Refinery.

The new Esso Cologne Refinery is laid out for a yearly throughput of 3.600.000 metric tons of crude oil. The area covered by this refinery is about 100 ha. The F. H. Kocks K. G., Consulting Engineers, Koblenz, Western Germany, were charged with the design and the supervision of the complete civil engineering work.

the clarification basins, the removal of sludge and light oil fractions were designed in a more advantageous way which deviates from the API standards.

a. Waste water distribution

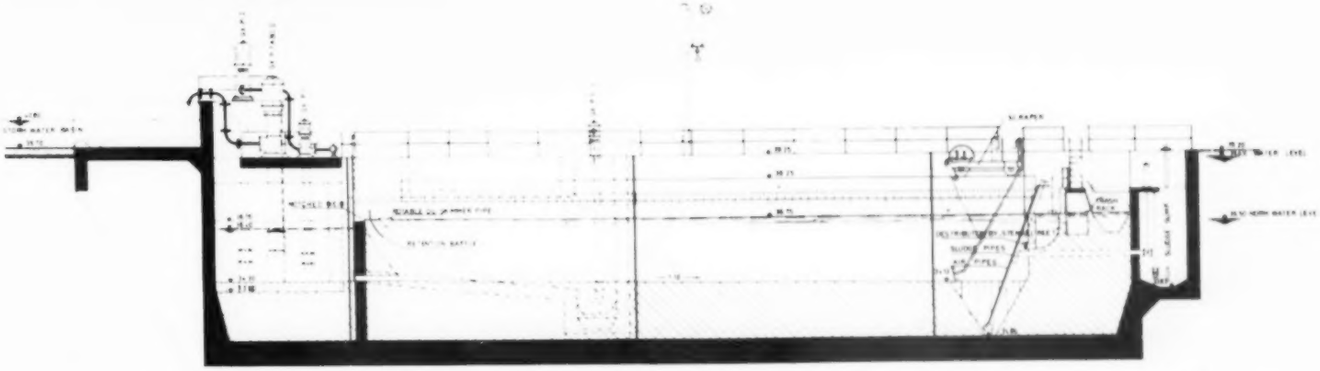
Decisive for the separating efficiency of such installations is the uniform distribution of the waste water over the basin cross section. Tests carried out at the Budapest university with different constructions of inlet distribution (immersed plate, distribution rods, Stengel distribution devices, etc.) showed that an excellent distribution was obtained with the "Stengel distribution devices" manufactured in the Michelbacher Hütte of the Passavant Company. (More than 90% of the basin is utilized.) For that reason, the waste water distribution with the aid of "Stengel distribution devices" is more effective from an operating standpoint and, furthermore, cheaper in construction, since moreover it will not be necessary to build a separator fore bay in which generally undesired settling of sludge takes place.

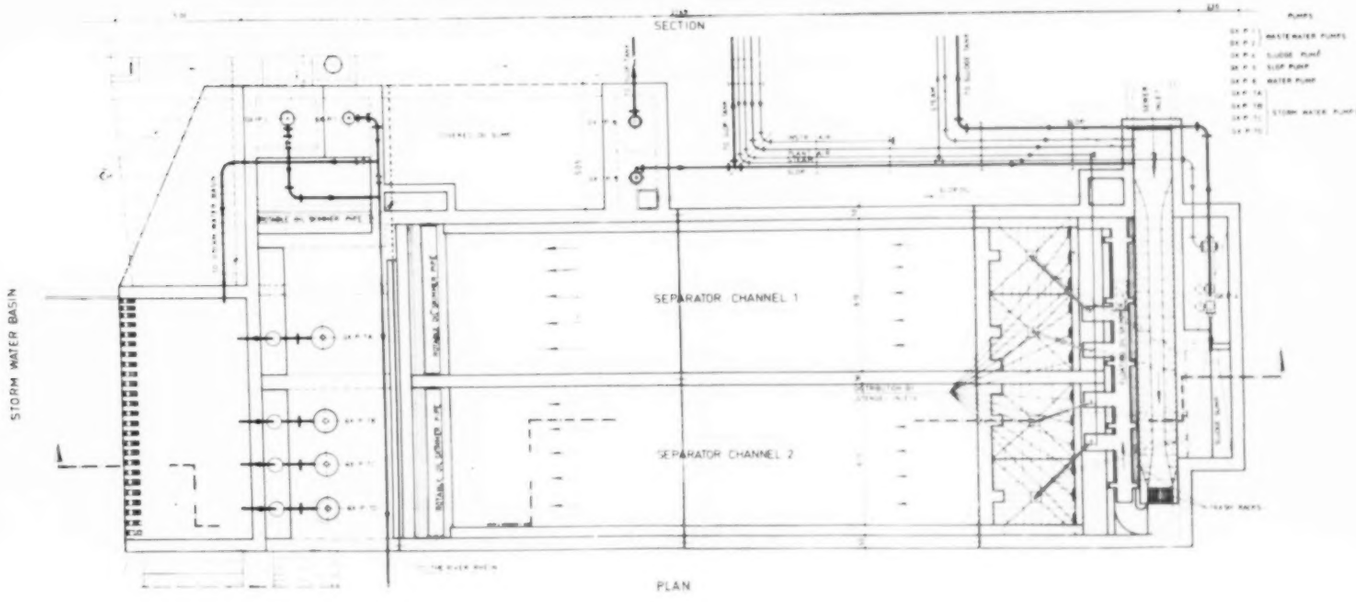
b. Slime and light oil removal.

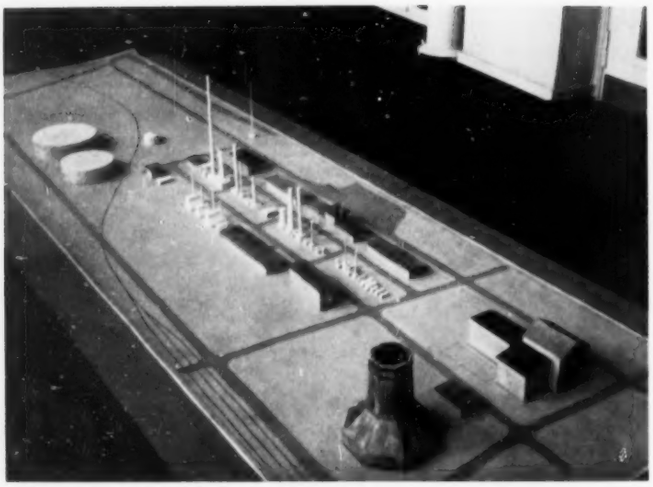
The slime and light oil removal is done in the installation provided for the Esso Cologne Refinery by means of a travelling scraper. The advantages of a travelling scraper when compared with a flight scraper, are the following:

1. All moving parts of the scraper are located above the water.
2. During operation of the travelling scraper only the narrow slime plate and the holding arms move in the water, whereas in the case of the flight scrapers the whole of the strap moves in water.

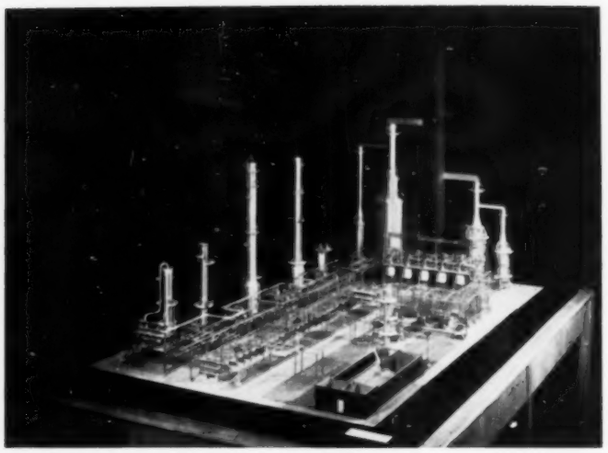
For those reasons, the travelling scraper causes *less* disturbance of the waste water flow. Oil separating plants provided with travelling scrapers have a higher separating efficiency and guarantee an undisturbed flow and operation.



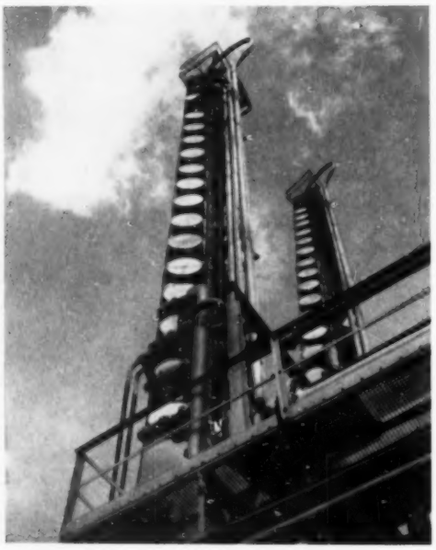




Preliminary model of a refinery.



Final model after completion of the design.



Gas fractionating plant. Photo courtesy Lurgi Gesellschaften, Frankfurt M.

Sovafiner and sovatermer. Photo courtesy Lurgi Gesellschaften, Frankfurt M.

Possibilities of future extensions with regard to increase in production and expansion of the production program.

Climatic conditions per day and per year.

Fresh water and waste water conditions.

Local building regulations.

Local approval and inspection provisions.

Economy and suitableness of the means of transportation to be used for raw materials and finished products.

Own generation of utilities or connections to existing feeders.

Which building materials and parts are available in the customer's country?

Clarification of the question as to how much supervisory, skilled and unskilled manpower has to be supplied for the execution of field work.

Clarification of the question as to how far administration buildings, maintenance shops, warehouses, sanitary installations, laboratories, plant houses or colonies etc. will be required.

Calculation of the suitable size of storage tanks for raw materials, intermediate and finished products.

Scope of sales and shipping facilities.

After these questions have been clarified and contractually settled between customer and engineering company the detailed planning of the installation can begin. The process to be used is definitely fixed in process flowsheets. With the aid of plot plans and models the general arrangement and the location of the various pieces of equipment are fixed. The engineer combines pieces of equipment in groups, machines in buildings, lays out the piping system and centralizes operating controls at suitable points.

Now the working out of details of plant equipment begins in the large drafting rooms of the engineering company. After these details have been laid down in drawings and specifications contact is made with the many suppliers involved.

Quotations are sent to the engineering company which checks them for technical suitability, prices, time of delivery and reliability of the suppliers. In this way constantly a selection is made with regard to the most economical and modern makes and of the most reliable and best suppliers in free competition thereby best serving the interests of the customer and guaranteeing a rapid and reliable growth of the work.

Thus, the economic effects radiate from the engineering company and the responsible planning engineer into the economic area of their city, their country and in many cases beyond that to supoliers in Europe and overseas. As far as required machinery like turbines, pumps, compressors, blowers, motors and many more are concerned, special products of numerous manufacturers are required.

These machines will be first thoroughly checked by the planning engineer and later on inspected on the test bed. A large number of tanks and vessels is required for the storage of the raw materials and the intermediate products and furthermore large tanks and storage space is necessary for the storage of the finished products so that they can be held ready for shipment and be dispatched suitably.

Fractionating towers in a motor fuel refinery. Photo courtesy Pintsch Bamag AG, Butzbach.

Plant for the production of sulfuric acid from hydrogen sulfide (vanadium contact process). Photo courtesy Chemiebau Dr. A. Zieren GmbH, Cologne.

Operation of the plants requires a large amount of apparatus, e.g. fractionating towers, scrubbers, agitators, mixers, separators, and so on. In particular, mention might be made of one special branch of equipment manufacturer namely that of heat exchangers; they play either as actual exchanger or as cooler or condenser an important role in the economic use of energy. In this connection power houses with their many ramifications, pump stations and cooling water systems and last but not least gasholders should also be mentioned.

The interconnection of equipment and machines with the aid of a piping system may be compared to veins in the human body. The system with many thousands of meters of pipe of various dimensions and pressure stages runs through the plant. Such a system requires particular attention since it must be able to handle increases and decreases in production, as well as starting up and shutting down the plant.

This piping system includes numerous globe valves, gate valves, cocks, fittings, steam traps and many others. The location of these has to be given due consideration during the design work and they should be properly installed in the field. In addition to these thousands of parts there is the brain of the installation, the instrument room, which by means of its many hundreds of measuring instruments and control devices automatically supervises and controls the plant operation in a reliable manner.

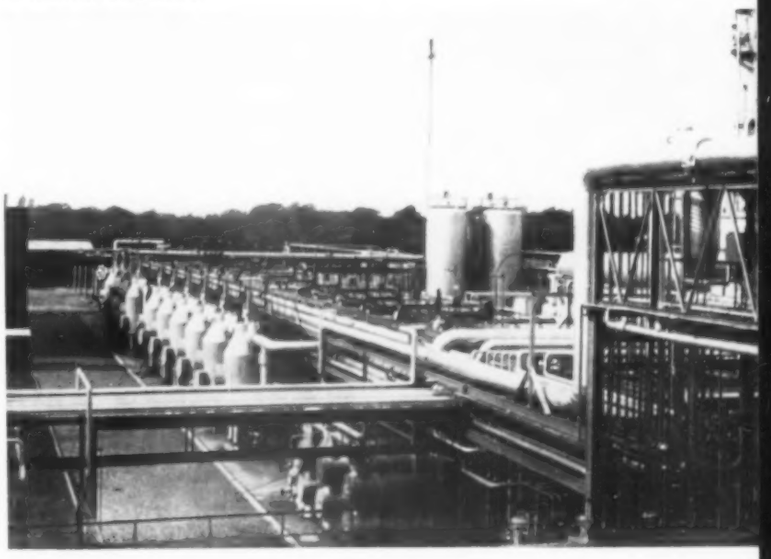
The success of the engineer does not depend on assembling these aggregates like prefabricated parts resulting in a pleasant picture for the spectator but on whether these elements function in a reliable and successful way to guarantee the desired quality and quantity of products. Aside from operating and administration buildings it is essential that laboratories, drafting rooms and repair shops are provided to maintain the plant in proper operating condition.

For the efficient operation of the plant the provision of roads and tracks and if possible of waterways should be given due consideration and be worked out in detail during the planning period.

In addition to this work to be carried out on the refinery site plant houses and a plant colony outside the plant may have to be provided.

When one considers the engineering work required for one single plant and then thinks about the many, many different processes which the engineers of those engineering companies have to build, one begins to realize the potenitial of process and engineering technique which German engineering companies must have at their disposal to participate in world competition and which potential is absolutely essential to assure work for their large staff of chemists

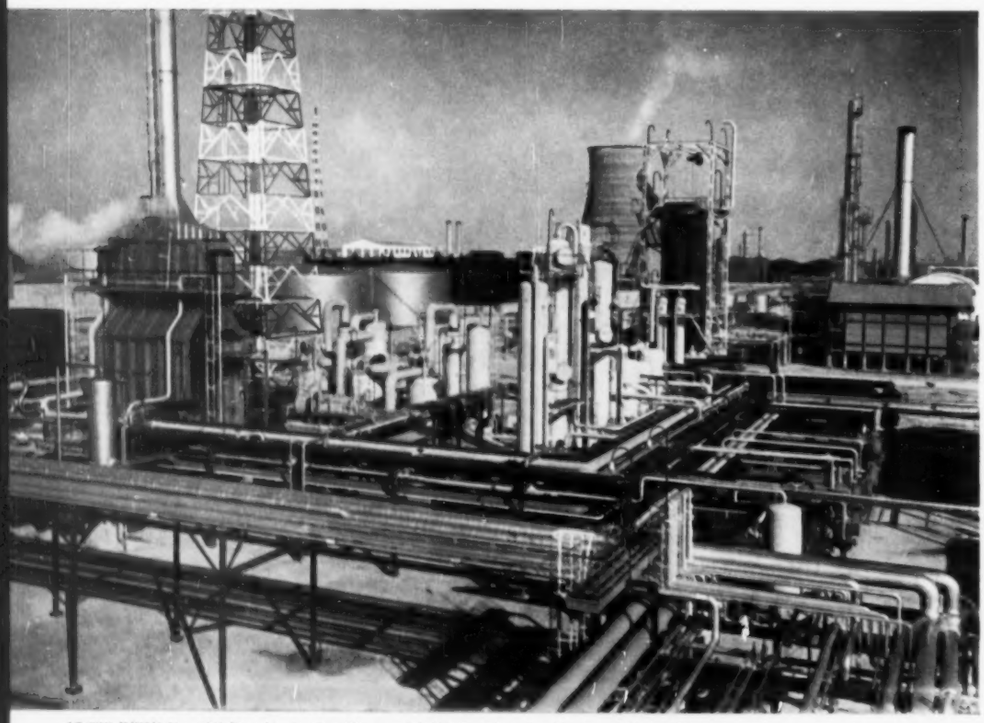
Partial view of a butadiene concentration plant (Esso process). Photo courtesy Carl Still, Recklinghausen.



LURGI

Petroleum Refinery Constructors

For more than 25 years, Lurgi has been working in the field of petroleum processing. Initially, Lurgi's work covered only European refineries but during recent years activities have been extended to overseas countries, and in particular to Africa and Asia. Lurgi constructs plants for all modern processes as well as complete refineries to the latest standard of petroleum processing technique, partly based on its own developments and partly in cooperation with American engineering firms.



15,000 BPSD Gas Oil Desulfurization Plant, with Diethanolamine Unit and Claus Plant

7,500 BPSD Esso Hydrotarmer

12,500 BPSD Houdry Catcracker

What is Lurgi?

General Contractor for the Urea Fertilizer Plant at Naju, Korea. Engineer and Contractor for the Refinery at Schwechat, Austria. Constructor of the Sulfuric Acid Factory at Cockle Creek, Australia. Licensor for the Iron Ore Sintering Plant at Saxonburg, U.S.A.

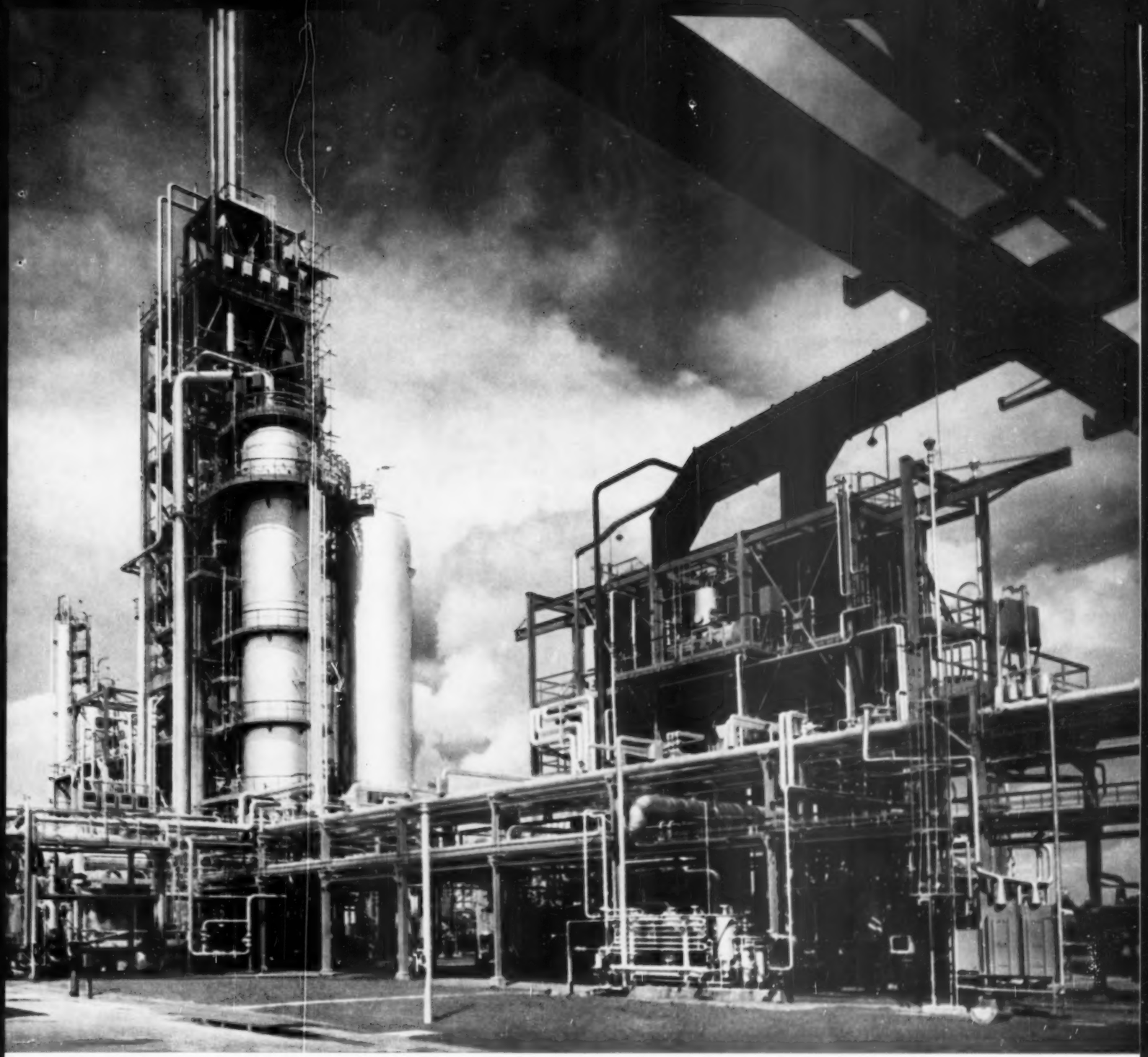
These are some typical examples.

Lurgi is the joint name of a group of engineering companies which are working in practically all fields of the chemical processing industry. The name of Lurgi originates from its predecessor, Metallurgische Gesellschaft AG, which was founded by Metallgesellschaft, Frankfurt (Main) as a subsidiary in 1897 and which chose "Lurgi" as their cable address.

The present-day Lurgi is one of the biggest engineering companies in Europe.

In 48 Countries of the World

Lurgi has a staff of more than a thousand engineers and chemists along with an appro-



priate purchasing and sales organization. Lurgi engineers and erectors are presently engaged in the construction of chemical processing plants in 48 different countries of the world under varying climatic and economic conditions. This means world-wide technical experience and contacts with all feasible supply sources.

480,000-Square-Foot Research Station

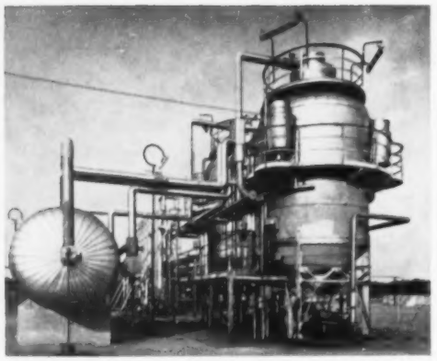
Lurgi's working principle is the performance of special technical services and the adaptation of processes and equipment to the specific requirements of its customers and the particular properties of the crude materials. The basis for this work is created by the wide-range development work carried out in Lurgi's research station in Frankfurt (Main). An area of 480,000 square feet accommodates modern laboratories and pilot plants for semi-technical and full scale operations. Apart from extensive facilities which permit analytical examination of any crudes or end products, all basic equipment for the most essential processes is available which may easily be combined to the processing units as required for any particular application.

Lurgi Gesellschaft für Mineraloltechnik

Lurgi started with the development of its own processes for the petroleum industry more than 25 years ago. At the time, Lurgi applied partly new and partly improved processes of distillation, absorption, adsorption and refining, such as high vacuum distillation, azeotropic distillation, adsorption of gasoline, butane and propane from natural gas by activated carbon, as well as hydrofining processes. A crew of petroleum technologists concentrated on this work and soon formed a special petroleum processing division within the Lurgi companies, which became the core of the present Lurgi Gesellschaft für Mineraloltechnik m.b.H.

Coal instead of Petroleum

Due to the shortage of petroleum in Central Europe, Lurgi's work took a course different from that in most of the other industrial countries. The petroleum technologists had to concentrate their efforts temporarily to upgrading, i.e. in particular to the liquefaction of coal, this being their chief inland raw material. The outcome from these activities was the development of the Ruhr-chemie Lurgi synthesis process, involving the hydrogenation of carbon dioxide under medium pressure with iron catalyst by Fischer-Tropsch—a process which is still world famous and which led to the construction of the Oil-from-Coal Plant at Sasolburg, South Africa, the largest plant of that type installed since World War II.

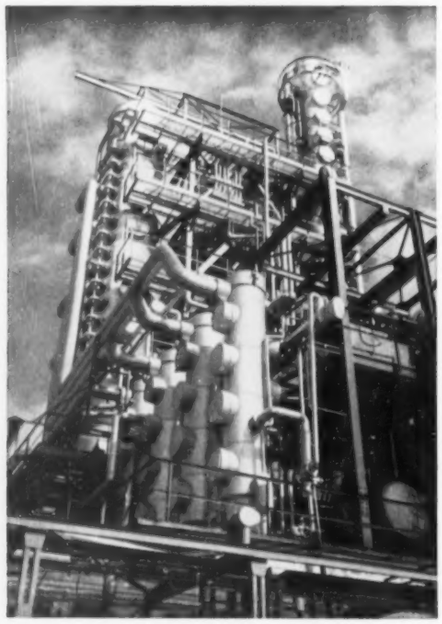


4,000 BPSD Lurgi Desalting Plant for crude oil

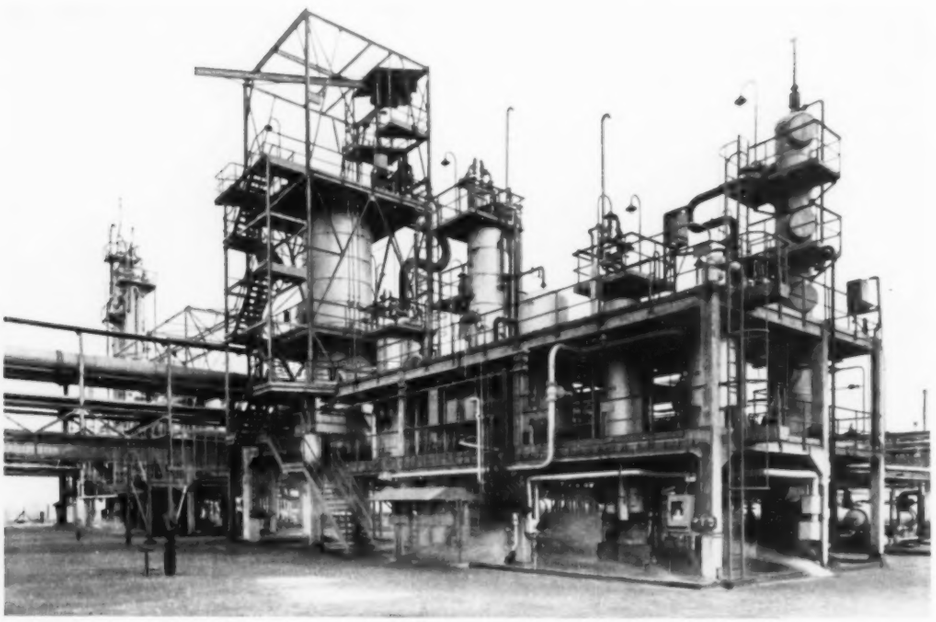
Lurgi Supersorbon Plant for the recovery of 130 BPSD of light gasoline from 33.5 × 10⁶ SCF of natural gas, with simultaneous removal of traces of hydrogen sulfide

LURGI

Petroleum Refinery Constructors



2,000 BPSD Lurgi Atmospheric and Vacuum Distillation



Esso Hydrofiner for 9,000 BPSD of gas oil

2,500 BPSD Polymerization Plant for the production of high-octane gasoline from olefins

Lurgi Petroleum Engineering Background

The rapid technical development of the petroleum industry in the United States necessarily led to the application of the newly developed processes also in Europe. Since 1950, Lurgi has been collaborating with large American engineering companies, such as Lummus, and later on with UOP, Esso, Mobil Oil, Kellogg and Braun. As a result of this fruitful cooperation Lurgi was in a position to make outstanding contributions to the construction of plants for all modern processes and complete refineries incorporating the latest developments of the petroleum processing techniques. The initial result from this cooperative work was the construction of a petroleum refinery in Germany with a throughput of 12,500 BPSD, which was the first refinery erected in Germany after World War II.

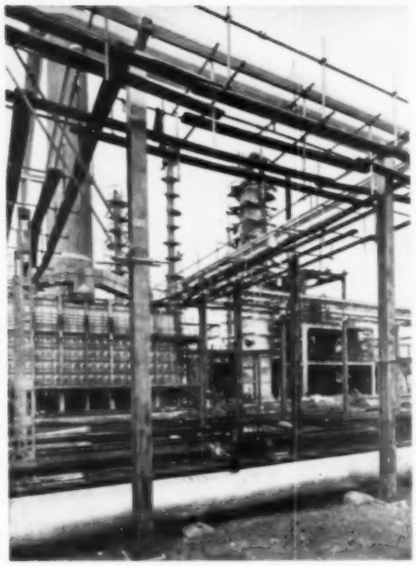
Subsequently numerous other plants were constructed, partly based on Lurgi's developments and partly based on processes licensed by others. These installations include amongst others:—

Atmospheric and vacuum distillation plants.
Thermal and catalytic reforming plants.
Catalytic polymerization plants for polymer gasoline.
Recovery plants for natural gases, cracked gases and other refinery gases.
Electrostatic desalting plants for petroleum.
Thermal and catalytic cracking plants.
Chemical refining plants.
Hydrofining plants for benzene, naphtha, kerosine and gas oil.
Fischer-Tropsch synthesis plants for the production of gasoline, gas oil, paraffins and waxes.
Cracking plants for the manufacture of ethylene and propylene.

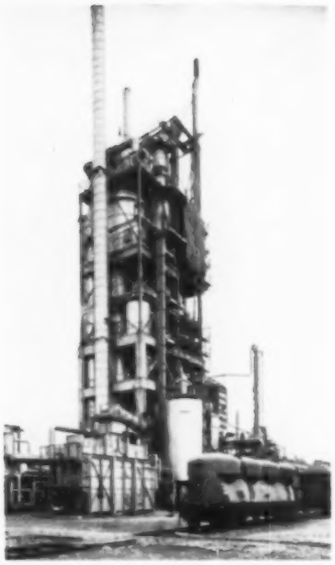
As a result of these wide-ranging activities, Lurgi assumed a leading position amongst the German refinery constructors.

Current Lurgi Activities

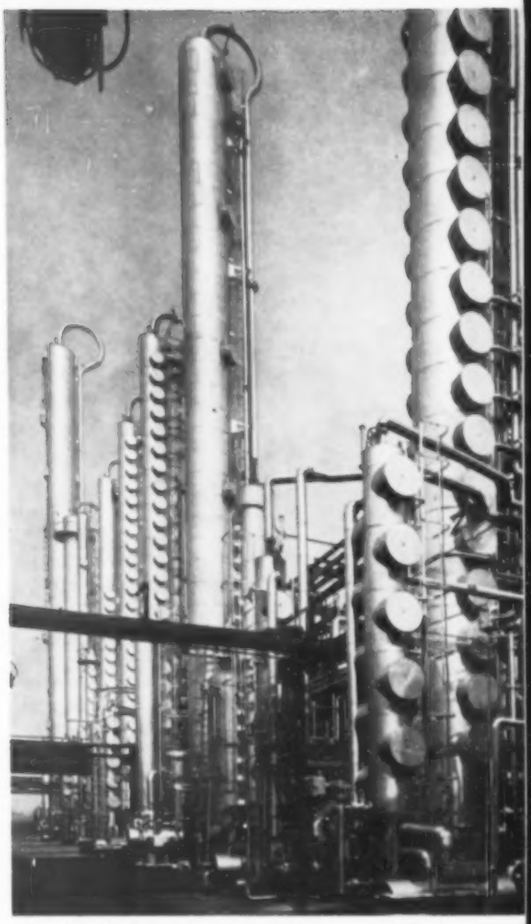
Among the outstanding installations presently under construction are the new Esso Refinery at Cologne and the extension of the Elmsland



Steam Cracker of Cologne Esso Refinery



Lurgi/Ruhrgas Cracking Plant for the production of olefins from 2,100 BPSD of gasoline



Lurgi Gas Recovery Plant for 3,000 BPSD of stabilized naphtha, propane and butane

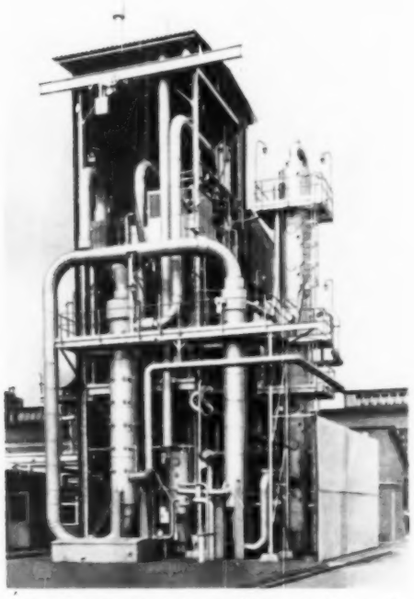
Petroleum Refinery at Lingen. In connection with the Cologne Refinery, Lurgi has carried out the engineering work on the major processing units, such as steam cracker and hydrofiner including offsite facilities. For the extension of the Lingen Refinery, Lurgi is supplying a 32,000 BPSD atmospheric distillation plant, the equipment for the hydrofining of gasoline and kerosine, for the removal of hydrogen sulfide and for the recovery of sulfur.

Moreover, Lurgi is actively engaged in the field of petrochemistry. One of its own developments in this particular line of work is the Lurgi Ruhrgas process (Sand Cracker) for the production of olefins from all kinds of crude and end products. The process has been applied already in two industrial plants. Other installations include plants for the cracking of low boiling range products in the tubular furnace (steam cracker); the latest plant of that type was built at Rheinische Olefin-Werke near the Cologne Esso Refinery. The licensor for this ethylene production plant was Kellogg.

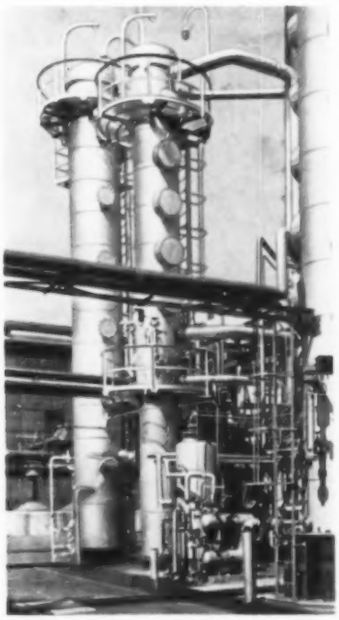
Other fields of Lurgi's present activities are the production of phenol via cumene, and the production of polyethylene, polyvinyl chloride, polystyrene, phenolic resins and urea resins.

Design and Construction of Schwechat Refinery

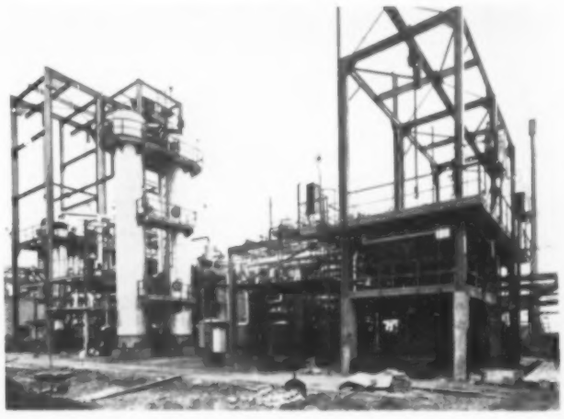
Lurgi is at present designing and constructing a complete refinery for the Austrian Oil Administration. The overall project includes a 35,000 BPSD crude unit, a 7,000 BPSD UOP Platforming unit for the production of motor fuel with 95 RON, gas recovery and chemical units and auxiliary facilities. A particular feature of this refinery is that it has to handle low-gasoline naphthene base and high-gasoline mixed base and paraffin base crudes. The new refinery is to replace, to a large extent, the four obsolete refineries of the Austrian Oil Administration which are in operation at the present time. This modernization will result in greater overall economics and profits.



Lurgi Refinery-gas Splitting Plant for 12.5 × 10⁶ SCFD of town gas



Lurgi Mercaptan Removal Plant for 2,200 BPSD of liquefied petroleum gas

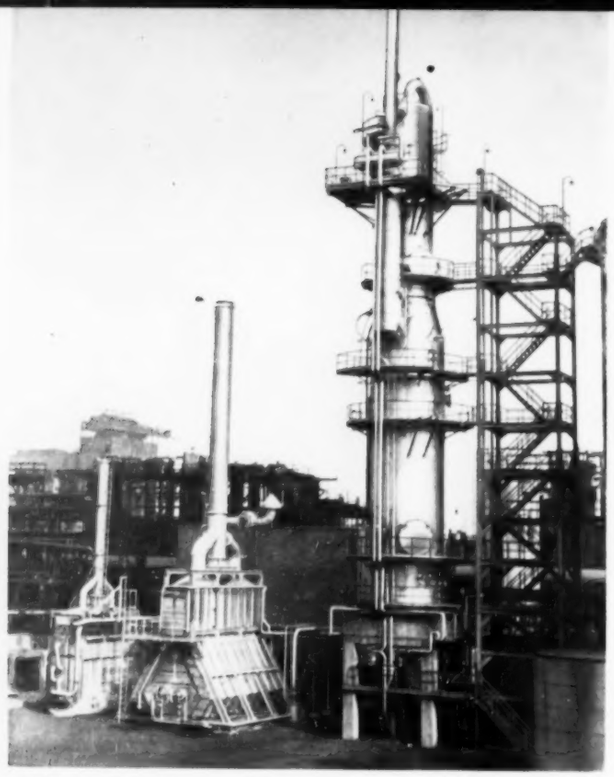


Shell Oil Gasification Plant for the production of synthesis gas. Throughput: 600 BPSD of bunker C-oil or brown tar oil

LURGI-GESELLSCHAFTEN

FRANKFURT (MAIN)

WESTERN-GERMANY



Orthoflow fluid catalytic cracking plant. Photo courtesy Friedrich Uhde GmbH, Dortmund.

and engineers from year to year. If, notwithstanding the keenest international competition, the industry of the world again and again favors German engineering companies with important orders this should clearly demonstrate not only the reputation which German technology enjoys abroad but also how much this engineering company means for the economic life of its home city, for the German national economy and nowadays for the European economic area.

In view of the large number of processes applied in crude oil processing and in the petrochemical industry this section "German engineering contributions to the processing of crude oil" cannot contain a detailed description of the many processes which are applied by German engineering companies. The advertisements of the German engineering companies listed in this special edition of WORLD PETROLEUM give a comprehensive picture of their manufacturing program. These and the photos of plants built by them show the reader that German engineering companies fully cover the extensive field of refinery and petrochemical technology.

The close cooperation between USA and German engineering companies in past years has time and again brought evidence of the efficiency and results of German planning and German technique. The cooperation which has existed for many years between German engineering companies and suppliers has proved its merits

Powerforming plant. Photo courtesy Friedrich Uhde GmbH, Dortmund.

and has been intensified and steadily enlarged. German companies have shown by their extensive activity in industrially underdeveloped countries that they can adjust themselves to the requirements of the customer and to the conditions of his country.

Active assistance to customers in connection with financial and foreign exchange problems shows that the German engineering companies render valuable pioneering services for the international economic area and for Europe collaboration beyond the interests of German exports and of the national economic area.

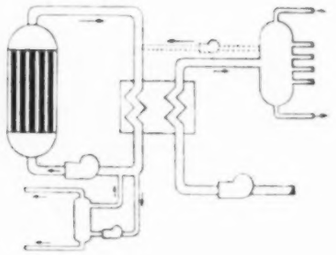
German engineering companies and the German industry recognized the European task with regard to the industrialization of the underdeveloped economic areas in the world and carried it out in peaceful competition of neighborly collaboration in the sense of a free market economy. German engineering companies are ready to tackle important projects and have at their disposal modern science and research, a great potential of mental and manual knowledge and last but not least extensive technical experience and comprehensive know how as these are required for he successful participation in the designing and construction of plants for the crude oil and petrochemical industries. With this review of the activity of German engineering companies and of the German planning engineer we extend to the reader our invitation to convince himself by means of an early visit to the advertising companies of their efficiency and to discuss in direct conversation with the chemists and engineers their intentions and investment possibilities.

You will everywhere find modern offices, pleasant surroundings and diligent and industrious people.

When personally visting us you will readily be convinced that by entrusting German engineering companies with the planning of your products you place this work in competent and reliable hands and that it will be considered as a "German engineering contribution to the processing of crude oil."

Hydrotining plant with sulfur recovery. Photo courtesy Friedrich Uhde GmbH, Dortmund.

Nuclear reactor for petroleum processing. Diagram courtesy VDI Zeitschrift, Düsseldorf.



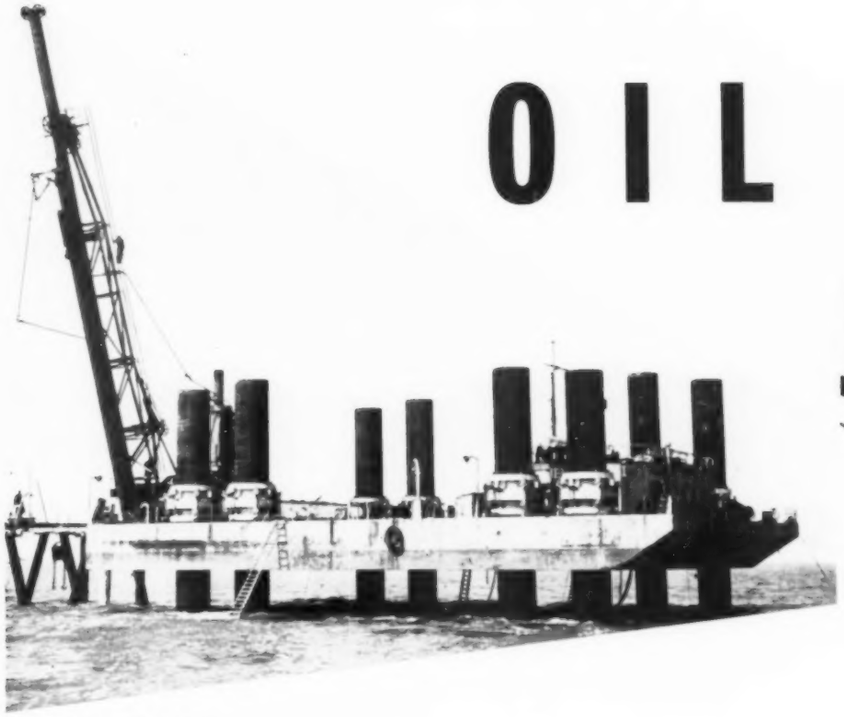


Foto-Trinkhaus, Wilhelmshaven

OIL JETTY

3900 FT LONG FOR DOCKING
OF 3 TANKERS UP TO 100,000 DWT.

. . . BUILT WITHIN A PERIOD
OF 10 MONTHS.

THIS WAS DUE TO THE USE
OF THE WORK PLATFORM
"HUBINSEL NO. 1" RAISED AND
LOWERED BY

DELONG AIR JACKS

Werkfoto

WILHELMSHAVEN

HUBINSEL

HUBINSEL GmbH.

HAMBURG 24, SCHWANENWIK 31

Hydrogen for Catalytic Hydrogenation

Hydrogen has vital functions in the refining industry and serves, among its many applications, to hydrodesulphurize gas oil fractions which are rich in sulphur. This process yields high quality fuel.

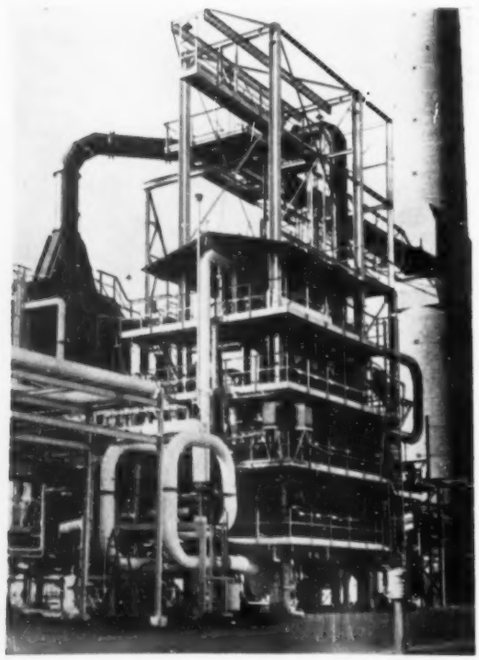
Gaseous hydrocarbons are available in abundant quantities in petroleum refineries and serve as raw material for the production of hydrogen. Several decades ago, PINTSCH BAMAG was the first to produce hydrogen from these gases, and this process has been used many times since. Hydrocarbons are mixed with steam and fed into a tubular system filled with a catalyst. These tubes are externally heated by the gas produced in the refinery.

If necessary, the gas to be reformed is desulphurized before entering the reforming furnace. As carbon monoxide is obtained during the reforming process, shift conversion units are frequently provided to convert carbon monoxide in hydrogen and carbon dioxide.

The carbon dioxide is removed by the Giammarco-Vetrocoke process in many plants supplied by PINTSCH BAMAG AG. This process is operated at high temperatures (about 60° C) and features reduced quantities of absorbent circulation and low solubility of valuable gas components, such as hydrogen. The regeneration of the absorbent solution can be made either with steam or air. High scrubbing efficiencies are reached.

PINTSCH BAMAG supplies the necessary equipment in order to produce high purity hydrogen from refinery gases.

The capacity of the standard units ranges from 20,000 $Nm^3/24$ h to 340,000 $Nm^3/24$ h per furnace.



The illustration shows one of the recent plants for reforming refinery gas.

The main equipment of such a gas reforming unit consists of the tubular furnace, the waste heat boiler for flue gas, or (in certain cases) reformed gas, the preheater for combustion air, heating and inlet gas.

A special department of PINTSCH BAMAG supplies all kinds of storage vessels for gases and liquids under high and low pressures, in particular, tanks for the storage of liquefied petroleum gases. During the past years a number of tank ships for the transport of liquefied petroleum gases were equipped with the necessary loading and unloading facilities.

One of the traditional fields of PINTSCH BAMAG is the metering and distributing of gases and stations of approved design, which are supplied to plants handling refinery gases. In particular, the PINTSCH BAMAG volume computer has found the approval of the industry. Gases of any pressure and temperature are computed, metered, and recorded in terms of the standard gas condition.

Tubular furnace for production of hydrogen for hydrodesulphurization, installed at a West German refinery.

Background Print:
Plant using the Giammarco-Vertrocoke process to remove and recover carbon dioxide from gases.

Our Production Program for the Oil and Natural Gas Industries comprises:

Plants and Equipment for:

Oil processing

Complete refineries for regeneration of spent oil

Oil cracking to produce:
Synthesis gas
Utility gas
Oil gas (Pintsch gas)

Removal of moisture and drying of natural gas

Recovery of hydrocarbons from natural gas, refinery gas and cracked gas

Removal of inorganic and organic sulphur from gases

Sulphur recovery (Claus process)

Cracking of natural and refinery gas

Storage tanks and holders for gases, liquefied petroleum gases, liquids

Installations for transfer of liquefied petroleum gases

Liquefied petroleum gas loading and unloading installations for tank cars and tankers
Adsorption plants for tank vents
Protective gas equipment

Treatment of:
Raw water
Circulating water
Waste water

Our Manufacturing Division supplies for these plants:
Storage tanks and holders for gases, LPG and liquids, regulating and measuring instruments for gases, automatic controls, oil and gas filters, heat exchangers and wasteheat boilers.

PINTSCH BAMAG

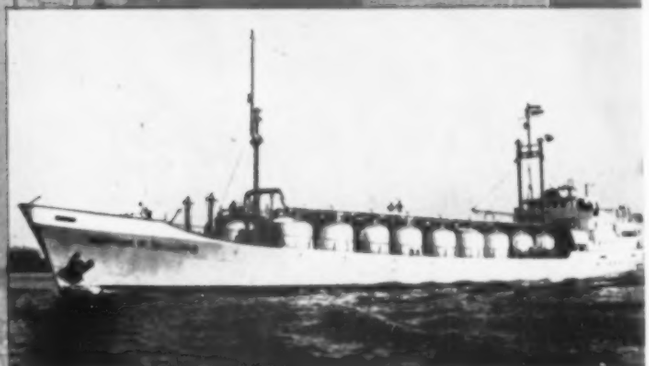
A K T I E N G E S E L L S C H A F T

HEAD OFFICE BUTZBACH / GERMANY
Represented in the USA by Columbia Technical Corp.
61—02 Thirty-First Avenue Woodside 77, New York USA

Carbon monoxide conversion under atmospheric pressure, capacity 91[illegible] Nm³/h. More than 40 shift conversion plants, mainly of the pressure-type design, have been supplied to customers abroad as well as in Germany.

Well-equipped specialized workshops of PINTSCH BAMAG. Fractionating tower under construction.

Measuring and regulating station equipped with PINTSCH BAMAG rotary piston gasmeters and volume computers.



Tanker for LPG, the transport, storage and unloading facilities supplied by PINTSCH BAMAG AG.

VGA 4/1-11

Still

designs and erects plants for the

CRUDE OIL AND CHEMICAL INDUSTRY

according to their own and other processes e. g.:

Distillation Plants as atmospheric or vacuum distillations for the recovery of gasoline, petroleum, diesel oil, crude lubricating oil, asphalt etc.

Refining plants for gasoline, petroleum, diesel oil etc.

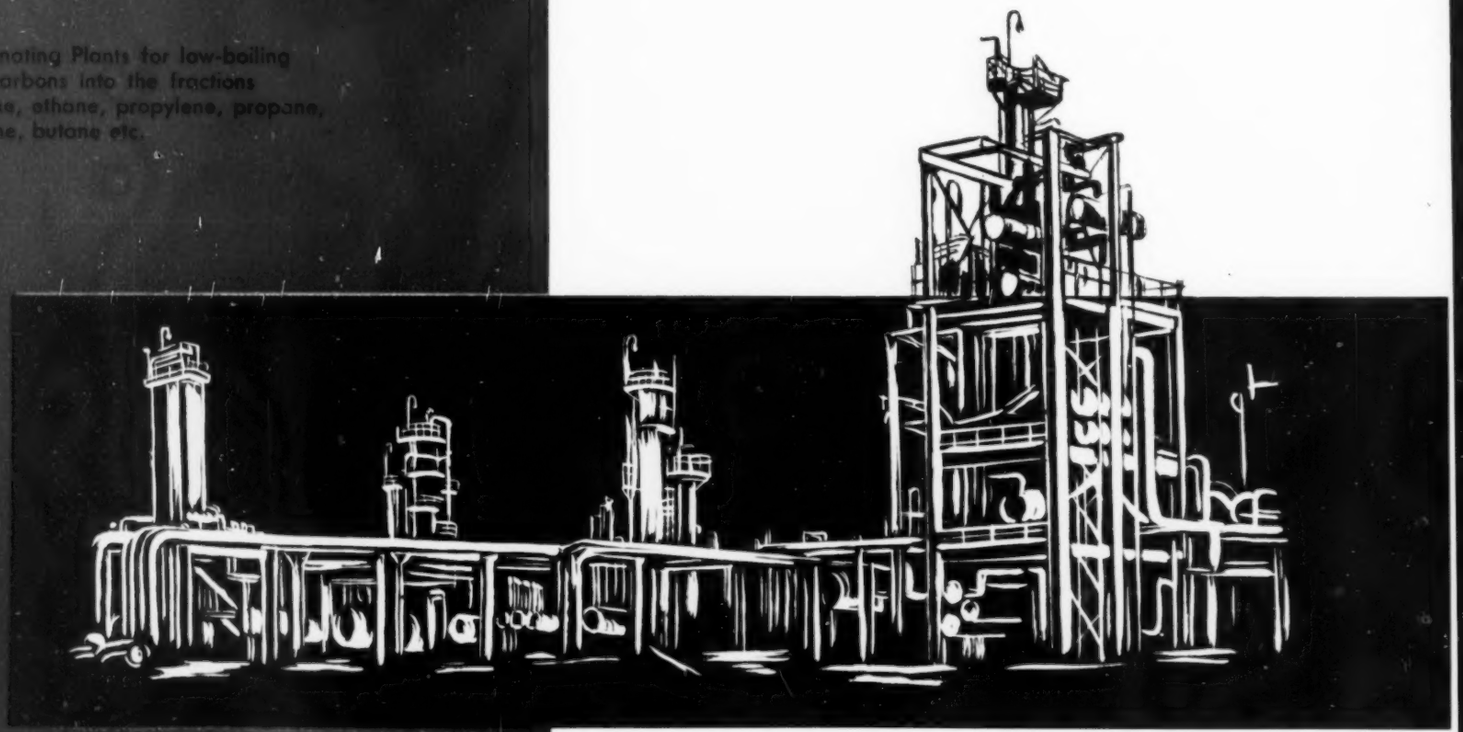
Plants for refining and dewaxing of crude lubricating oil

Cracking Plants, Scrubbing Plants

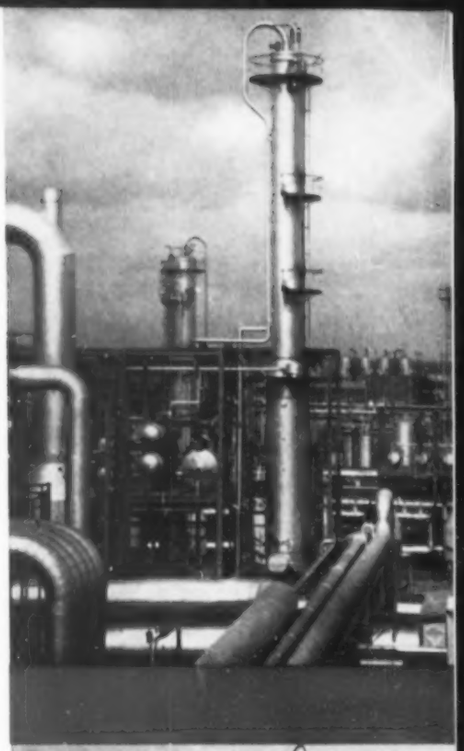
Plants for the recovery of gasoline and low-boiling hydrocarbons from refinery gases and natural gas

Fractionating Plants for low-boiling hydrocarbons into the fractions ethylene, ethane, propylene, propane, butylene, butane etc.

Reforming Plants
Butane dehydrogenation Plants
Butadiene concentration Plants
Ethylene recovery
Propylene purification
Alkylation Plants etc.



FIRMA CARL STILL RECKLINGHAUSEN



The evolution of the crude oil industry has been impetuous and impressive. As refineries were looking for ways and means to increase their economy they tried, in particular to convert the light hydrocarbons, in the beginning only obtained as motor fuels or even only as fuel gases, to important intermediates for the chemical industry. To realize these intentions a new branch of industry was created, called the "petrochemical industry."

For this special branch of industry various processes were developed, at first in the USA, the pioneering country for the processing of crude oil, and some years ago these processes have also entered Europe.

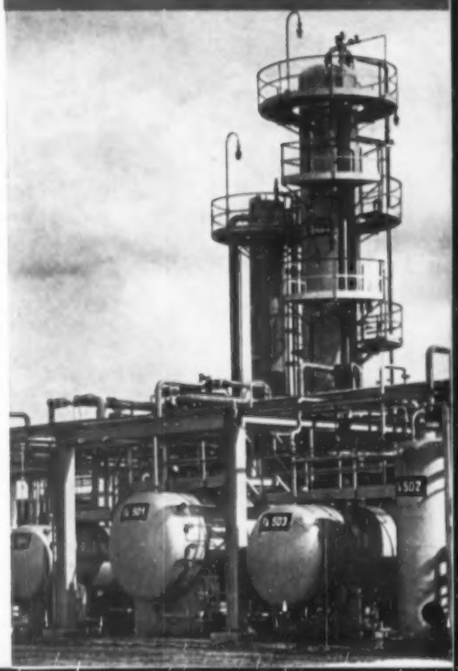
The following is a description of 3 plants which only lately have been erected according to American processes with the assistance of German engineering firms.

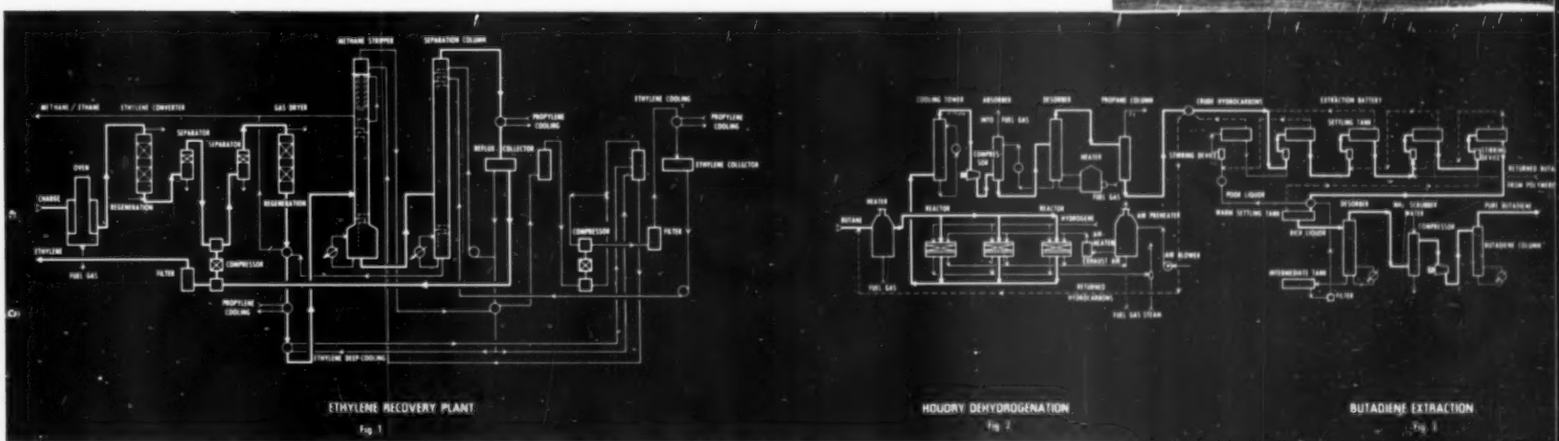
Fig. 1 is an illustration of a plant for the production of ethylene of a purity of 99.8 mol per cent according to a process developed by the Esso Research and Eng. Corp. including the selective conversion of the acetylene contained in the feed to ethylene. The initial material is a cracking gas from which the butadiene already has been extracted. It is characteristic for this plant that besides propylene as chilling agent the final cooling is done by a recycled stream of ethylene.

Fig. 2 is a flow diagram illustrating a plant for the conversion of n-butane to crude butadiene, operating according to the Houdry Process. The conversion of n-butane is performed at a temperature of about 1112° F and a pressure of 2.15 psi in the presence of an aluminum oxide catalyst activated with chromium. The heat required for the conversion of butane to butadiene is supplied by heat storage in the catalyst bed. Heating periods and reaction periods are following each other at short intervals. In order to accomplish a uniform continuous operation, Houdry employs several reactors.

Formerly the process provided for 5 to 7 reactors which were connected in series and which on contact changing had to be completely shut down. Now the use of 2 reactor groups connected in parallel, each consisting of 3 reactors, was for the first time realized on a German plant. From now on, when changing the contact material, one reactor group can stay in operation.

Fig. 3 is an illustration of the butadiene concentration, that means the recovery of pure butadiene according to the process of the Esso Research and Engineering Corp. The C_4-hydrocarbons containing the butadiene are fed in liquid form to an extraction battery in which the butadiene is selectively absorbed by a cooled copper-ammonium-acetate lye (CAA lye). The CAA lye (rich lye) saturated with butadiene is heated and the butadiene recovered in forms of vapours in desorber. The separated CAA lye (poor lye) is returned—after cooling by heat exchange with water and cooling agent—to the extraction battery. The recovered butadiene is scrubbed, compressed, liquefied and stabilized. The hydrocarbons not absorbed by the CAA lye are returned to the Houdry Conversion Plant. Several auxiliary processes under the same operation schedule permit a smooth performance of the pure butadiene recovery.

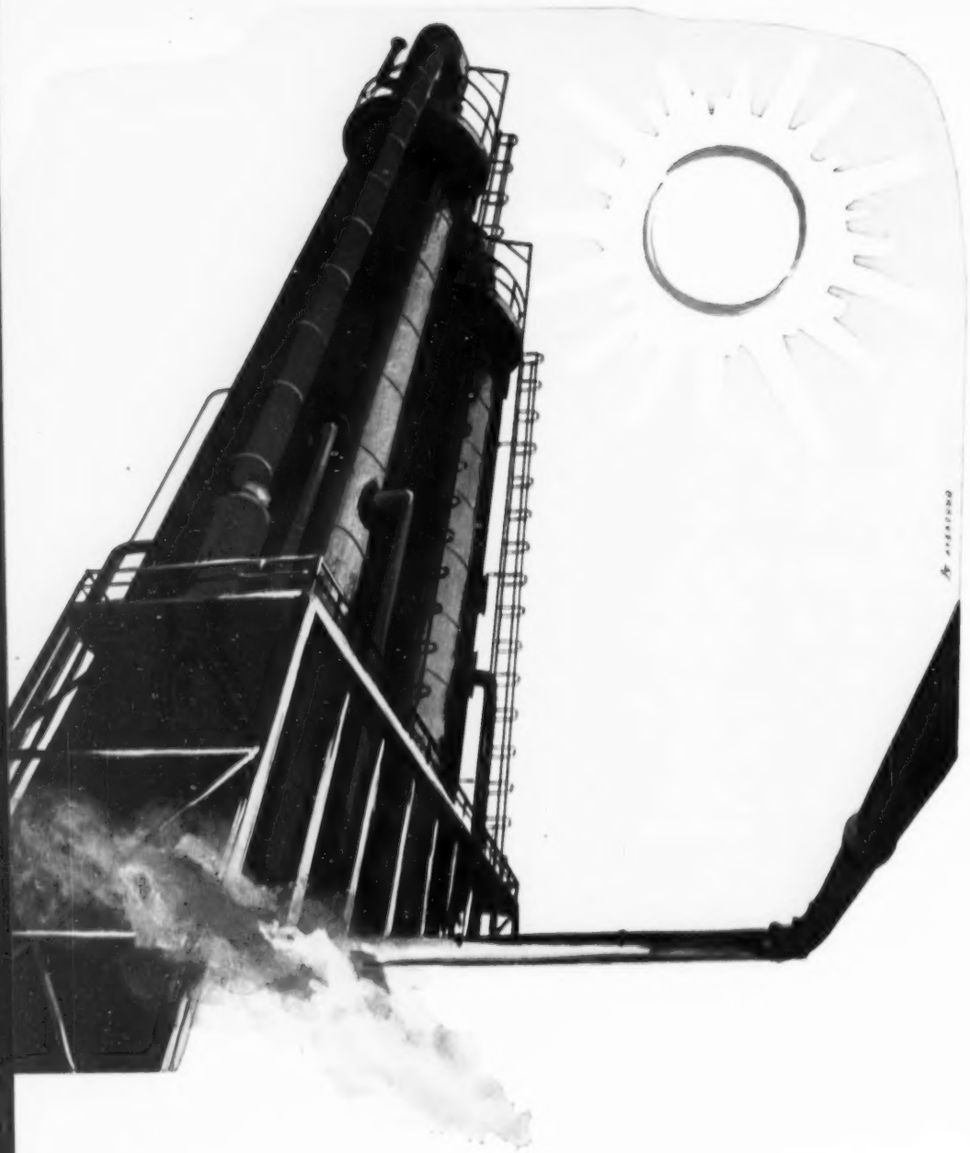




ETHYLENE RECOVERY PLANT
Fig. 1

HOUDRY DEHYDROGENATION
Fig. 2

BUTADIENE EXTRACTION
Fig. 3



UHDE'S FIELD OF ACTIVITY

Plants for the processing of crude and synthetic oils
Distillation and fractionation plants
Desalting and treating plants
Plants for the recovery of sulfur
Plants for hydrogenation and cracking
Lubrication oil plants
Plants for the production of petrochemicals
Plants for the production of:
- Plastics and synthetic resins
- Plasticizers
- Phthalic anhydride
- and other organic chemicals

FRIEDRICH UHDE GMBH DORTMUND (GERMANY)

DR. FRIEDRICH UHDE
Gründer, Teilhaber und Mitglied
des Aufsichtsrates
der Friedrich Uhde GmbH

DR. FRANZ KÖHLER
Geschäftsführer der
Friedrich Uhde GmbH,
Vorstandsmitglied der
Knapsack Griesheim AG

Friedrich Uhde GmbH is an engineering company engaged in the chemical field, with headquarters in Dortmund, Germany. Engineering offices are located both in Dortmund and in Frankfort Main-Offenbach and its equipment manufacturing plant is in Hagen, Westfalen. The company is a subsidiary of *Knapsack-Griesheim AG*., whose main office is at Knapsack near Cologne, and which itself is a subsidiary of *Farbwerke Hoechst AG* of Frankfort Main-Hoechst. The close cooperation with *Farbwerke Hoechst AG* and *Knapsack Griesheim AG*., in particular in the inorganic, organic and petrochemical fields is demonstrated by the founding by these companies of the *Hoechst Uhde International GmbH*, Frankfort Main-Hoechst, their representatives abroad advise the customers of Friedrich Uhde GmbH. in all fields.

Friedrich Uhde GmbH was formed in 1921 as an engineering organization by Dr. Friedrich Uhde, then a young civil engineer, and he retains part ownership of the company. Early in his career, Dr. Uhde demonstrated his capabilities in chemical plant operations and as an engineer in the design of plants to produce nitric acid by ammonia combustion using the Ostwald Process.

This background reinforced his interest in engaging independently in engineering and in 1921 he formed his own organization in Dortmund. Initially the company designed nitric acid plants and facilities for conversion of nitric acid to ammonium nitrate, ammonium sulfate, and other fertilizer chemicals. Later, a 1500 psi ammonia synthesis process was developed, becoming known as the Mont Cenis process, permitting complete plants for both ammonia and fertilizers with auxiliary facilities to be designed by the Uhde company. Beginning about 1928 various plants were built by the Uhde company in Germany, England, France, Holland, Japan, Manchuria, Russia, and the United States. Specialized equipment, pumps, and instruments for high pressure processes were developed and manufactured in the company's plant at Hagen. During this period the Uhde company entered into coal hydrogenation research and operated its own development laboratory. One of the results of this program was the successful development of a process whereby partial hydrogenation of coal permitted ash and residue separation by filtration. This process was called the Primary Bitumen Process. Development programs in such fields required extensive laboratory facilities and financial support which could not be furnished readily by the company at that time. Therefore, in 1937 Dr. Uhde relinquished majority control to Ammoniakwerk Merseburg GmbH (part of I.G. Farbenindustrie AG.) and the company became a limited corporation. Later developments showed this to be an appropriate and fruitful decision. Friedrich Uhde K.G. thus acquired the benefit of Merseburg's experience in Haber-Bosch ammonia synthesis, methanol synthesis, the nitrogen fertilizer industry, in the coal hydrogenation and petroleum fields.

During the years prior to the second World War, and during the war as well, the company was responsible for the erection of many plants, particularly in Germany. Friedrich Uhde K.G. established a second large engineering office at the Leuna plant of Merseburg in order to carry out this program. In addition to ammonia, nitric acid, and fertilizer plants, the more important projects included new plants for hydrogenation and petroleum operations. Among these was a plant for hydrogenation of coal tar at 10.000 psi, using Leuna's process and experience, and included product fractionation and up-grading. These projects also included a large number of synthetic fuel fractionation units, and liquefied gas plants.

Uhde entered the lube oil field and erected propane deasphalting and dewaxing plants, and other selective solvent extraction units. The company became closely associated with the Leuna research and development program for high octane fuels in Germany and was given responsibility for the installation of large aviation gasoline and blending components plants. Included were units for high pressure dehydrogenation and hydroforming of straight run gasoline, dehydrogenation and isomerization of paraffins produced by hydrogenation, olefine polymerization, alkylation for iso-octane and other aviation gasoline production facilities. The Uhde company was particularly successful in this field and built large scale production units directly from laboratory experience. These plants were placed on stream with essentially no start-up difficulties despite the fact that new developments were being employed for the first time. For example, excellent quality alkylate was immediately produced in a plant in which the

For information please contact the local representative of

HOECHST-UHDE INTERNATIONAL GMBH FRANKFURT (M) HOECHST
Brueningstrasse **Telephone 31 05 01**

DR. ERICH SACKMANN
Geschäftsführer der
Friedrich Uhde GmbH

DR. JOHANN D. GERSTEIN
Geschäftsführer der
Friedrich Uhde GmbH

refrigeration was furnished directly by feed stock evaporation. Uhde also participated in the construction of plants for the production of high quality lubricants from ethylene.

Postwar developments, particularly the unfortunate division of Germany, resulted in the loss of the company's large engineering office at Leuna. For some years activity in Uhde's specialized fields was far from satisfactory. During this period management looking to the future, broadened the company's scope, for example, by cooperation with American engineering companies regarding new refining processes, and engaged in joint refinery projects. This led to the construction of a thermal and several fluid catalytic cracking units in Germany and Yugoslavia. Design work and equipment delivery were accomplished for a large synthetic motor fuel plant in South Africa. In the inorganic field, an increasing demand for chlorine prompted the company at the inducement of ***Farbwerke Hoechst AG***, to engage in the design and erection of complete chlorine and caustic soda plants based on the use of mercury cells. These mercury cells were developed originally by I.G. Farbenindustrie AG. and continuing development is being carried out by Uhde in conjunction with ***Farbenfabriken Bayer AG.*** and ***Farbwerke Hoechst AG.*** which operate large mercury cell plants. Mercury cells, in comparison with diaphragm cells, produce high purity caustic soda in excess of 50 % concentration. Installations have recently been placed on stram in the United States, England, Venezuela, Brazil, Finland, Spain, France, and Switzerland.

Further developments were made during these years in the company's original field of ammonia synthesis and fertilizer processes. Thus a quench type converter was developed, and improvements were made in a 6400 psi converter to produce liquid ammonia without auxiliary refrigeration. The fertilizer program was extended to include processes for production of complete fertilizers by treatment of phosphate rock with nitric acid and addition of potash salts. The Inventa Process for urea synthesis also was added. New nitrogen fertilizer units were built in various countries including Germany, Finland, and Sweden.

As a result of re-organization of the I.G. Farben successor companies, Uhde's corporate structure was altered and it became Friedrich Uhde GmbH as a subsidiary of ***Knapsack-Griesheim AG.***, itself a subsidiary of ***Farbwerke Hoechst AG.*** This again resulted in a considerable extension of the company's field of activity to include new developments in inorganic and organic chemistry, particularly regarding acetylene, petrochemicals, and synthetic fibers. Mention may be made of several other developments.

A new Knapsack 40,000 – 50,000 KW completely enclosed calcium carbide electric furnace has been placed in operation. Complete recovery of carbon monoxide is possible for use in other operations, such as methanol or ammonia, thus resulting in more economic acetylene production. Knapsack also has developed a modern and efficient rotary furnace to produce granular calcium cyanamide from calcium carbide and units for sodium tripolyphosphate, phosphoric acid, and electric furnace phosphorus have been installed. ***Farbwerke Hoechst AG.*** has developed a low pressure polyethylene process, a polypropylene process, and a high temperature pyrolysis process to produce acetylene and ethylene from gaseous or liquid hydrocarbons. Other processes, both inorganic and organic, have been developed.

In recent years Friedrich Uhde GmbH has been awarded contracts for the installation of chemical plants in various parts of the world – the U.S.A., Argentina, Brazil, Venezuela, Austria, England, Finland, France, Greece, Italy, Yugoslavia, the Netherlands, Portugal, Romania, Sweden, Switzerland, Spain, Turkey, India, Japan, Korea, Pakistan, Egypt and South Africa. The company, with a staff approaching 1000 in number, is available for chemical plant projects throughout the world.

As already mentioned above ***Hoechst-Uhde International GmbH,*** Frankfort/Main-Hoechst, formed to support and develop our foreign activities, welcomes inquiries from other countries. In the United States inquiries may be directed to ***Hoechst-Uhde Corporation,*** 8204 Empire State Building, New York 1, N. Y.

For information please contact the local representative of

HOECHST-UHDE INTERNATIONAL GMBH FRANKFURT (M) HOECHST
Brueningstrasse **Telephone 31 05 01**

UHDE'S FIELD OF ACTIVITY

Plants for the production and purification of synthesis gas from coal, coke, liquid fuels and gas
Plants for the production of synthetic ammonia
Plants for the conversion of ammonia to nitrogen fertilizers
Plants for the production of synthetic urea
Plants for the production of mixed and compound fertilizers
Plants for the production of nitric acid
Plants for the processing of synthetic methanol
Furnaces and thermo-technical installations
High-pressure installations including those for extremely high pressures

FRIEDRICH UHDE GMBH DORTMUND (GERMANY)

2

Civil engineering companies for aboveground, underground, concrete and structural steel work

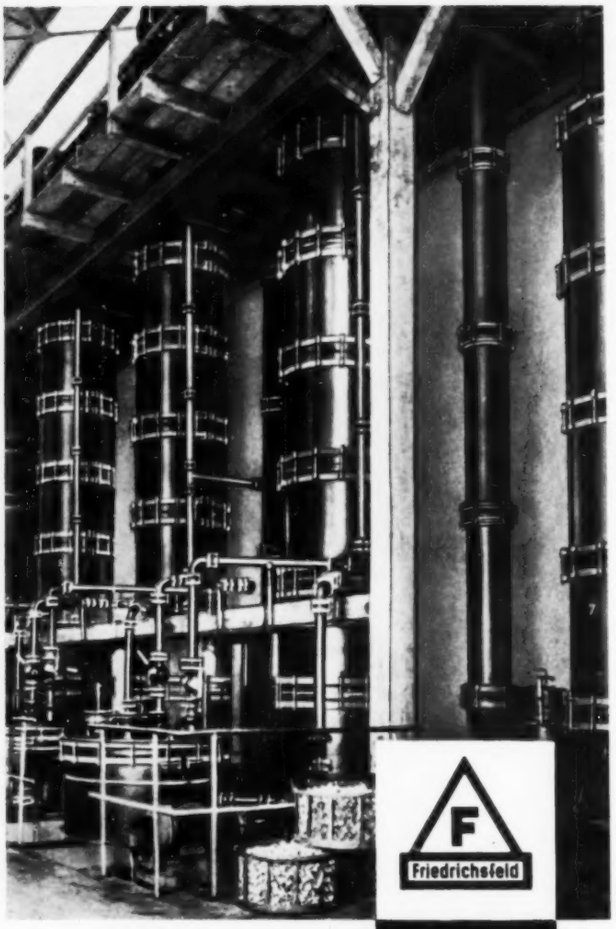
WHEREAS in the case of industrial buildings the architect determines the practical fashioning and the outer shape, the engineer determines the selection of the suitable material and the technical execution of the construction of the building. Through this interlinking of architecture and building technique the style of the industrial buildings is shaped which style in the course of time and with the change of people showed certain heterogeneities and characteristic features but still always reflects throughout the whole of the world the iron-clad laws of technical suitability and the purpose for which it is to be used. In particular, in case of refineries and large size chemical plants this style must be entirely adapted to the technical purpose of the installation since its appearance is so fixed and determined by the outward shape of the gigantic pieces of equipment like columns, tanks, cracking towers, furnaces and the very extensive, large size pipeline system; each deviating building style would distort and destroy the uniformity of the technical plant. Therefore, with regard to industrial buildings engineer and architect must so select the building materials and the style of the shaping of the various buildings that they conform to the laws of static and material strength without making them appear clumsy but on the contrary so that they fit in harmoniously in the technical picture of the plant.

In all sections of crude oil processing the building technique is applied in many different ways. The eye is most attracted by aboveground structures, buildings as well as the many open steel structures and pipe bridges. It goes without saying that road and track building also consitute an important part of each industrial project.

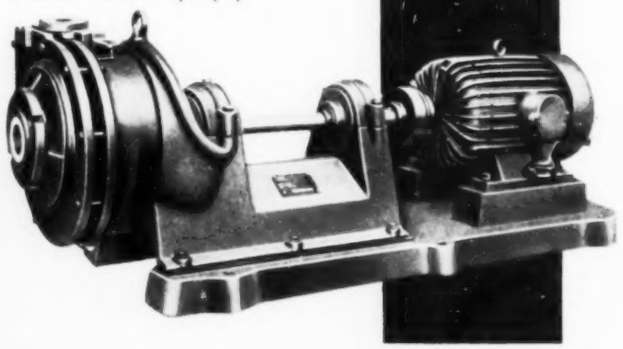
Work involved in the construction of a great many foundations comprising small ones for blowers up to the enormous foundations for heavy equipment and large machines is normally underestimated because the work involved is mostly unobserved. Only the engineer fully comprehends and realizes the amount of building materials used for those underground structures and the many thousands of working hours required for the execution of this work and for earth work in general beginning with the grading and levelling of the building site up to the conclusion of all civil engineering work.

In view of the large amount of different products to be shipped

Jetty in oil harbor. (Photo courtesy Strabag Bau AG, Cologne).



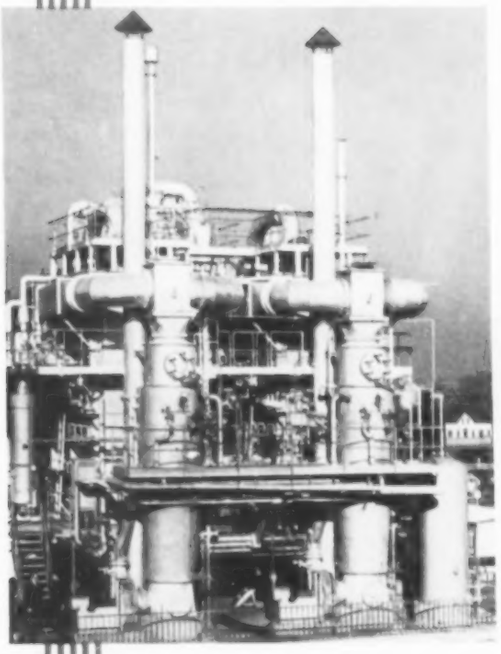
Special Stoneware
"TEMPERIT"
resistant to temperatures up to 500° Centigrades, acid-proof
Acid-proof stoneware
Technical Porcelain
Products made of Plastic material
Artificial Carbon and Electrographite
Plant, Apparatus
and pertaining equipment
Columns, Pumps, Exhaust-Fans,
Heat-Exchangers, Valves,
Pipes and accessories,
Vessels, Laboratory-Equipment



DEUTSCHE STEINZEUGWARENFABRIK
MANNHEIM-FRIEDRICHSFELD
WESTERN GERMANY

The handling of projects for oil and gas processing demands

EXPERT DESIGN, ENGINEERING AND CONSTRUCTION

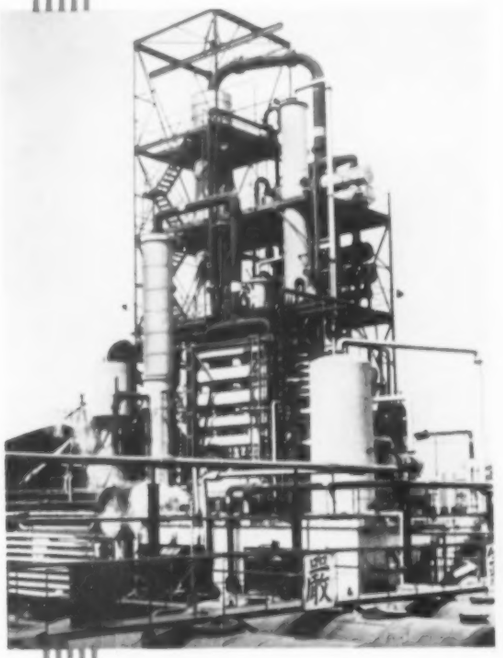


OTTO TAIL GAS REFORMING PLANT

The skill of our engineering staff, experienced in meeting the most different conditions, assures the utmost in design and profitability regardless of size or scope of the project.
We design and erect complete plants or individual process units for

- **GAS PURIFICATION AND REFORMING**
- **PETROLEUM PROCESSING**
- **PETROCHEMICAL PROCESSING**
- **OIL SHALE RETORTING**

We may help answer your problems.



OTTO VACUUM DISTILLATION PLANT

DR. C. OTTO & COMP. GMBH. BOCHUM

Federal Republic of Western Germany
Bochum, Christstraße 9 · Cable address: Ottokoks Bochum

Argentine:	Otto Argentina, Buenos Aires
France:	Société pour l'Industrie des Combustibles, Paris
India:	Dr. C. Otto & Comp., Indian Office, Calcutta
Italy:	Carbotecnia Soc. p. Azioni, Genova
Japan:	Nihon Otto K.K., Tokyo
Netherlands:	Otto-Simon-Carves N.V., The Hague
Spain:	Sociedad Anónima Otto, Madrid
U.S.A.:	Otto Construction Corporation, New York

HOCHTIEF

AKTIENGESELLSCHAFT FÜR HOCH- UND TIEFBAUTEN

Pipeline underneath Rhine River

DESIGN AND EXECUTION OF ALL CONSTRUCTION WORK FOR THE OIL INDUSTRY

OIL JETTIES · PIPELINES AND SIPHONS
FUEL DEPOTS · REFINERIES

HOCHTIEF AKTIENGESELLSCHAFT

ESSEN · WEST GERMANY

USA
PAVILON
1958 World Exposition, Brussels.
Circular contruction supported by posts
Diameter of pavilion: 341 ft.
Roof suspended on wire ropes
Weight of the structural steelwork: 1400 metric tons
Time of erection: 2 months.
KWE
Steel building construction – bridge construction – machine construction Structural steel for the crude oil and synthetic oil industry and their relatet branches.
KÖLN-WESSELINGER EISENBAU MBH
WESSELING / GERMANY

it is desirable to locate the refinery next to a water way. Just like in the case of the underground structures the amount of building materials and of working hours required for the building of quays and quay walls is not obvious to the eye after the work is completed.

In connection with the large amount of building materials required for the execution of building work in various sections of the industrial plant and in view of the fact that this building work must be completed before the installation of equipment and machines begins it will be clear that the planning engineer as one of his first duties will have to see to it that the technical specifications and the main building designs are made available to the building contractors.

At this time decisions about the use of the most suitable building materials will also have to be made. In particular in the petroleum industry certain suitable types of construction have proven their merits and are found over and over again: large-weil-lighted compressor and machine rooms, extended pump rooms mostly of half open construction or the typical instrument room in closed construction with an adequate skylight, the vast steel structures for supporting the large pieces of equipment of tanks with the pertaining staircases or the operating platforms directly connected to towers and high columns. This type of construction requires to a large extent the use of steel structures.

Steel can be used in many different ways for high loads so that nowadays only reinforced concrete is its only competitor and then in particular if used in form of prestressed concrete. The application of this prestressed concrete brought about an increased use of the modern light metals of high strength. Although steadily higher requirements are placed on the building materials, architect and engineer can develop a better and more pleasing style of industrial buildings, since after all the aboveground structures constitute a daily reminder of the high ability of the people active in the building industry. The supply of future management personnel, designers and engineers for office and field work in the building industry is guaranteed by the close connection with science and research, with the technical universities in Germany and abroad and last but not least with the large number of technical schools in Germany.

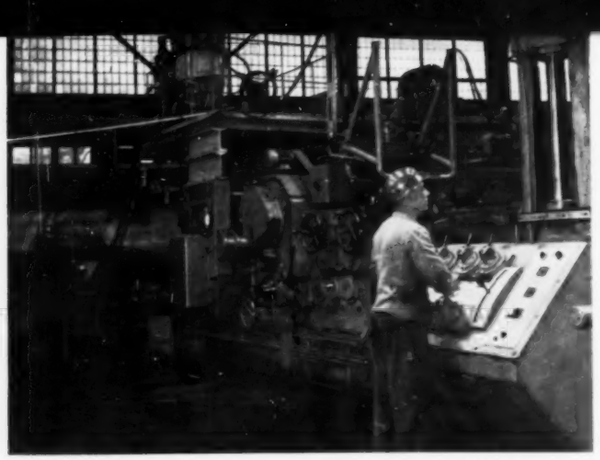
Petroleum processing technology steadily places higher requirements on the fireproof and acid-proof ceramic materials. In particular the requirements with regard to the resistance against wear and tear and against temperature changes for these materials have become stringent during the last years. Furthermore the structure density and the mechanical strength of these building materials could be so improved that nowadays the white stoneware which is practically free of iron constitutes a building material which meets the requirements with regard to resistance against very high temperatures, against temperature changes and is completely resistant against acid attack.

The intensive expansion of German installations for petroleum processing and for the petrochemical industry strongly promoted the building industry. In this respect consideration is not only given to the normal plant construction but also to the laying of pipelines which nowadays directly connect German refineries and also those of the neighboring countries with the harbors of the North Sea and the Mediterranean. In the early part of this year the pipeline from Wilhelmshaven to the Ruhr district was placed in operation. In connection therewith the harbor of Wilhelmshaven had to be completely remodelled. In particular a new form of jetty had to be built for the large size tankers so that they could discharge their cargo practically in the immediate vicinity of the large storage tanks.

Although only in the second half of 1957 the decision was arrived at to lay the pipeline and to extend the Wilhelmshaven harbor facilities the work was so expeditiously carried out that in the early part of 1959 the first petroleum cargo was discharged. Many more remarkable performances of German architecture and building technique could be mentioned; however, the available space does not allow more than a general resume as given above and a reference to photos included in the text and to the advertisements of the relevant companies.

3

Pipe— Manufacture, assembly and field construction



Spiral pipe welding plant. (Photo courtesy Hoesch Export GmbH, Dortmund).

Pipe as means of transportation and as a component of modern equipment enables petroleum to make its long way from the oil fields to the consumer.

The rapid growth of consumption and conquest of world markets by this liquid source energy may be attributed in an important degree to pipe. The use of pipe as a low cost carrier was a factor in the astonishing increase of production and consumption. In the course of time numerous possibilities of application in practically all fields of technology were opened to pipe so that nowadays pipe and in particular steel pipe constitutes one of the most important building elements. Pipe is used for the transportation of liquid, gaseous and even solid materials.

With the aid of drill pipe, casing and tubing, petroleum resources at great depths are opened up. In the construction of boiler houses, equipment and refineries with their many sided service requirements such as high pressures and high temperatures, steel pipe has become an indispensable building element. Also in underground and aboveground construction, in the manufacture of vehicles and machines and for many other purposes pipe is a much required material.

This multiplicity of application possibilities brought about the early development of a sizeable pipe industry in Germany in which seamless and welded steel pipe was manufactured in all desired dimensions. The manufacturing program comprises pipe with a diameter of 6 to 8 mm (about ¼ to 1/3 inch) up to the largest diameters that can be shipped. The production of seamless pipe is restricted by its economic limit which lies at a pipe diameter of between 600 and 900 mm (about 24 to 36 inches).

The most important manufacturing methods for seamless pipes are: the reciprocating roll piercing process (Mannesmann rolling process), the Stiefel process (Automatic Mill), the Ehrhardt process (Push Bench) and the extrustion process as well as the cold rolling and the hot and cold drawing process. The choice of process to be applied depends on the diameter, the wall thickness and partly also on the material from which the pipe is to be made. Depending on the diameter welded steel pipe is made from band steel or sheet metal. Different welding processes applied include resistance welding, Induction welding and Union Met welding.

For pipe dimensions up to $2\frac{1}{2}$" nominal size the Fretz-Moon welding process is also applied. In principle, longitudinal seam welding is preferred for the manufacture of welded pipe. In case of a pipe with a relatively small wall thickness in comparison to diameter spiral seam welding is nowadays used. When applying this latter process as well as when using the longitudinal seam welding it is possible to weld on both sides with the Union Melt process. Aside from the manufacture of steel pipe the fabrication of pipe from cast iron, non-ferrous metals and plastics should be mentioned. These types of pipe have found in conformity with their specific properties certain fields of application.

A long time ago the dimensions and the materials from which pipe is made were to a large extent standardized for different fields of application. However, pipe manufactured by German companies is not only made in accordance with German standards (DIN) but also in conformity with the various internationally adopted inspection regulations. This versatility of German pipe production is largely due to the fact that from the beginning a large part of the production was destined for export.

Of the different types of pipe industrially used the most important ones will be enumerated below. In doing so special attention is given to those used in the petroleum industry.

Casing.

Seamless pipe in dimensions from $4\frac{1}{2}$" O.D. up to 20" O.D. with short and long threads and couplings in conformity with API standard 5 A is made of material meeting the API quality specifications or of high strength special material.

It might be mentioned that casing pipe subject to severe conditions can be delivered with special joints which have a particularly high shearing strength and good sealing properties.

Tubing.

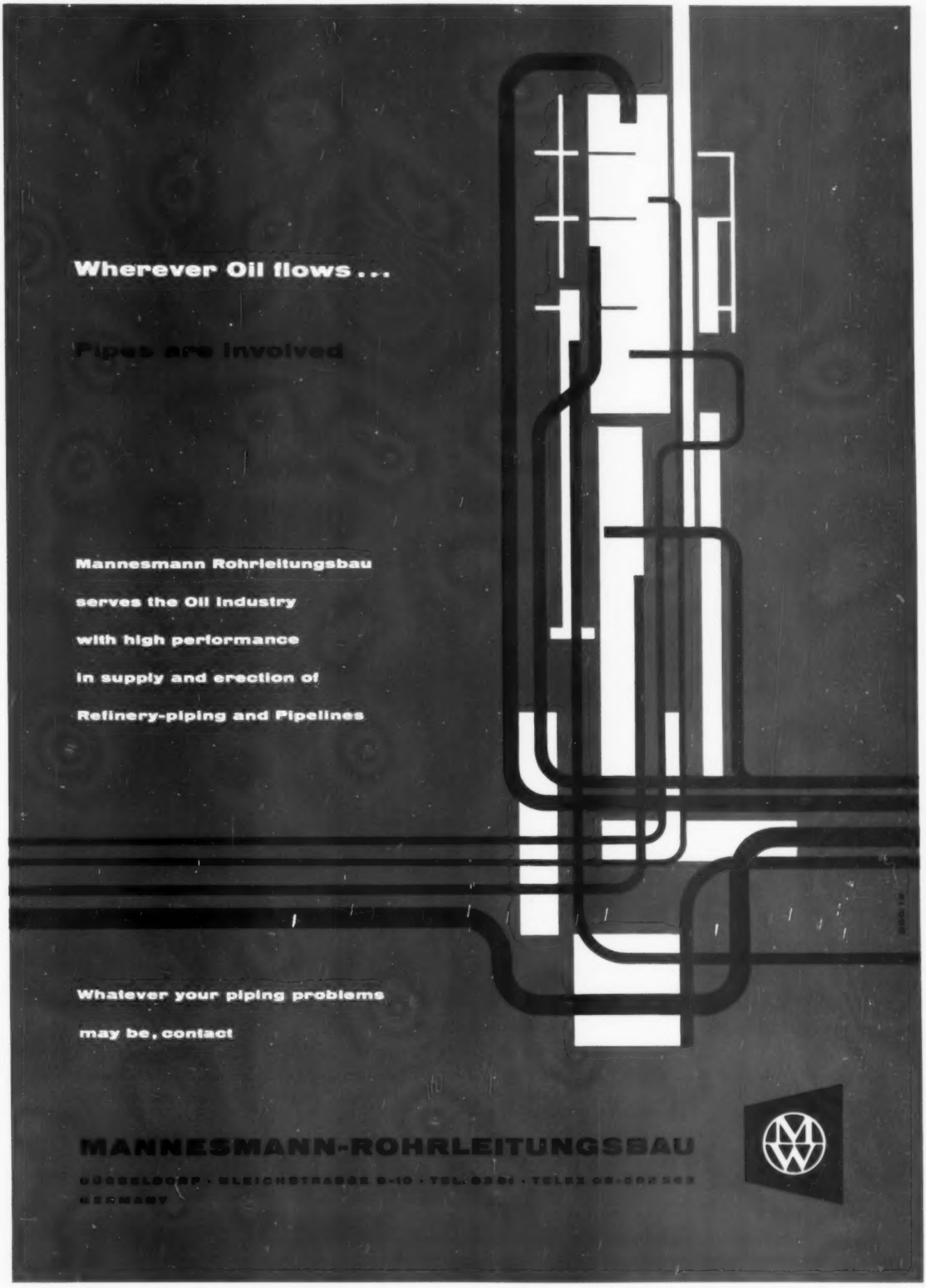
Seamless pipe is manufactured from 1.05" O. D. up to $4\frac{1}{2}$" O. D. non-upset and external-upset in conformity with API standard 5 A made of material meeting the API quality specifications or of special material. Also tubing can be provided with special joints.

(Continued on page 122)

Pipe bridge structure with pipes. (Photo courtesy Friedrich Uhde GmbH, Dortmund).

Castings Pipes. (Photo Courtesy Phoenix Rheinrohr AG, Dusseldorf).

Installation of an underground pipeline. (Photo courtesy Phoenix Rheinrohr AG, Dusseldorf).


Wherever Oil flows ...
Pipes are involved
Mannesmann Rohrleitungsbau
serves the Oil industry
with high performance
in supply and erection of
Refinery-piping and Pipelines
Whatever your piping problems
may be, contact
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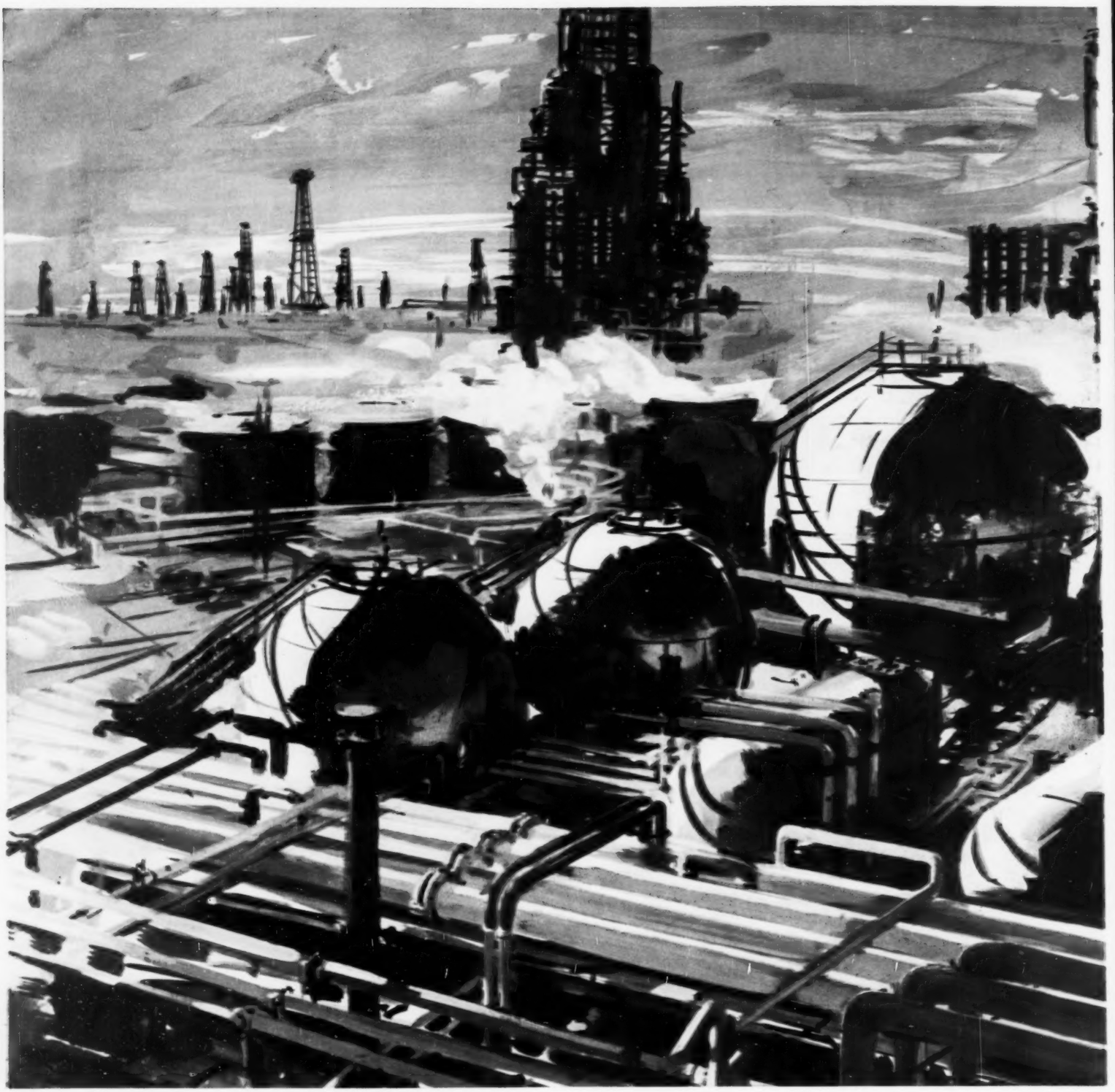


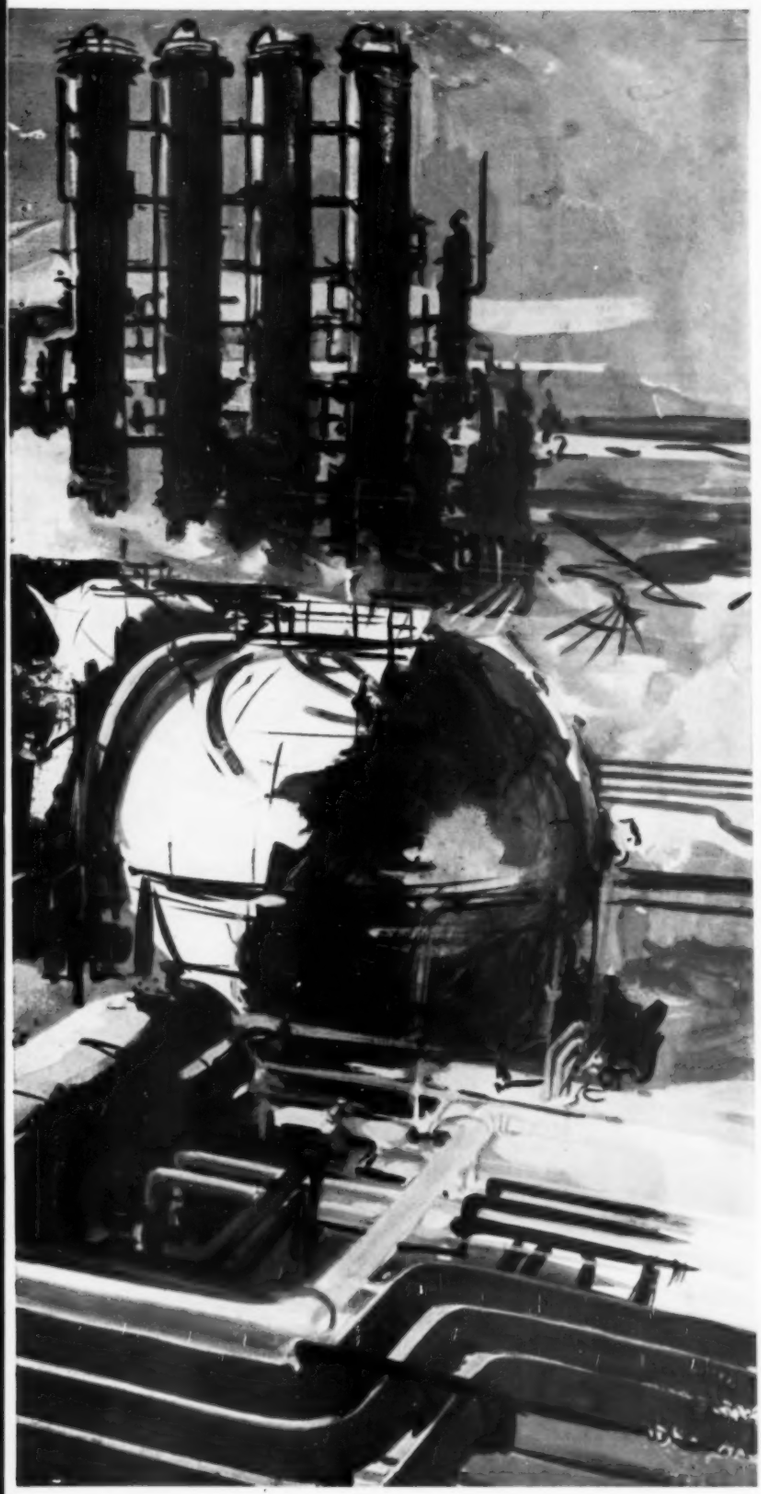
Over, under and around go the miles upon miles of Mannesmann steel tubes in modern refineries

MANNESMANN

DÜSSELDORF · GERMANY

Steel manufacturing plants and pipe mills in Germany, Brazil and Canada · Representatives all over the world

869-1e



MANNESMANN AND *Oil*

This is the age of oil unearthed, tamed, channelled through pipe.

There was no answer to the oilman's problems until the Mannesmann Brothers invented the seamless tube as you see it today in the world's oil fields and refineries. Indeed, the very first pipeline, of Mannesmann steel tubes, was laid from Baku to Batoum, and since then Mannesmann pipelines have been crossing the continents from well to port or refinery, Mannesmann drill pipe and casing are boring miles deep into the earth, and intricate structures of Mannesmann tubes process the oil in refineries.

Realizing the need to keep in step with continuing development, in both the scale and the technique of transport and refinery operations, Mannesmann has always made it a principle to maintain the closest possible contact with the oil companies. As a result of this fruitful teamwork and the research done in company-owned chemical, physical, metallographic, and other laboratories, Mannesmann steel tube today plays an outstanding part all over the world in pumping, drilling for, transporting, and refining petroleum.

Since the strains imposed upon the tubes in an oil refinery are tremendous, the equipment must be heat-resistant, stainless, and capable of withstanding various kinds of corrosion. Here again Mannesmann seamless or welded tubes and reactors of high-grade steels are in constant, urgent demand.

Another example of Mannesmann at work: Offshore islands standing on Mannesmann steel tubes, with platforms one or two storeys high, enable supertankers, whose draught often prevents their mooring at port or refinery piers, to discharge or fill their tanks on all sides of the dolphin platform.

The cornerstone of the Company's success in the steel pipe and plate industry has always been the insistence on perfecting its products to the last degree. Mannesmann engineers put your inspiration into practice — help you create fuel and all the derivatives of crude oil.

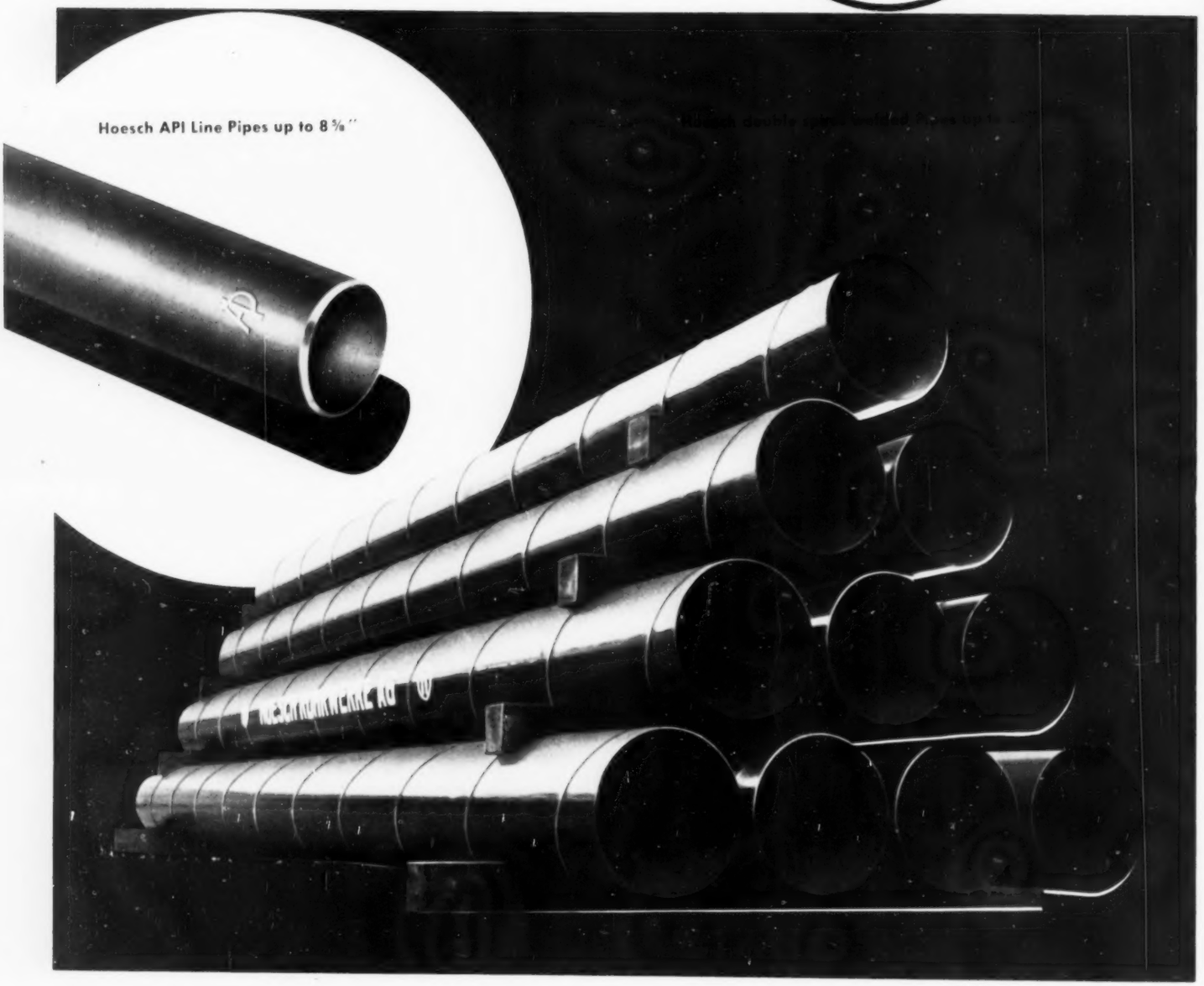
The wide range of Mannesmann products in this field includes:

drill pipe · casing · tubing to API standards (also extreme line casing and tubing manufactured under licence of Spang Chalfant) tool joints · drilling rigs

Pipeline according to API standards

Refinery equipment, such as
Piping of carbon and alloy steels · reactors · towers · columns tanks and containers of every kind · heat exchangers · coolers high pressure vessels · valves and fittings

Complete landing stages in tubular steel dolphin construction and offshore installations for the bunkering and unloading of tankers



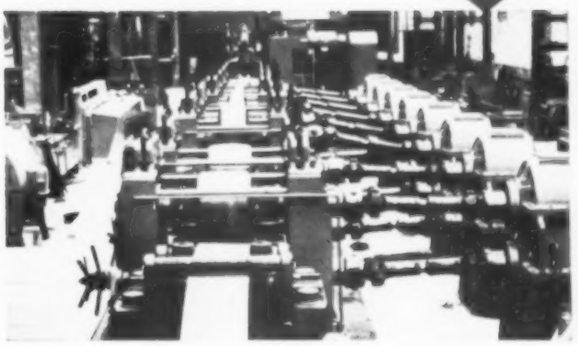
HOESCH EXPORT GMBH · WESTERN GERMANY · DORTMUND · SUDWALL 21-23

AMERICAN HOESCH INC. 375 PARK AVENUE, NEW YORK 22, N. Y.

Quality requires permanent improvement of the equipment. Hoesch has always tried to meet this requirement through their investment program. The Hoesch steel works deliver quality steels of every kind. The Hoesch rolling trains offer a wide rolling program. Here the steel strip is manufactured, too, which corresponds to the API specifications as far as quality and tolerance are concerned.

At the recently established plant of the Hoesch Rohrwerke A.G. at Hagen the steel strip is formed to electric resistance welded pipes up to a dimension of 8 5/8". These pipes are supplied with the API monogram and meet the specifications for line pipes API 5 L and API 5 LX.

The Dortmund-Barop Plant of the Hoesch Rohrwerke A.G. produces, from sheared wide strip, both inside and outside welded Hoesch spiral pipes in accordance with the Ellira Welding Process, up to a diameter of 60"; these pipes are used for gas-, oil- and water lines of large diameters as well as piling pipes.



HOESCH

(Continued from page 116)

Drill pipe.

Seamless steel pipe in dimension from $2^3/_8$" O. D. up to $6^5/_8$" O. D. in conformity with API standard 5 A provided with either screwed, heat shrunk or welded tool joints made of material meeting the API quality specifications or of special material.

Line pipe.

Seamless or longitudinal seam welded pipe in dimensions from $^1/_8$" nominal size up to 36" O. D. in conformity with API standards 5 L or 5 LX. Pipe of dimensions beyond the API standards up to sizes which still can be shipped are also manufactured. Aside from the materials corresponding to the API quality specifications this line pipe can also be delivered of special steels suitable for extremely severe conditions.

Pipe for distillation and cracking plants and other processes.

This type of pipe can be delivered in all desired sizes of material in qualities meeting prevailing operating conditions.

Pipe for steam boilers and equipment.

For this purpose pipe in all required sizes are available and can be made of the customary types of steel but also of special steels with heat, corrosion and hydrogen resisting properties. These special steels permit their use for constructions subject to severe conditions.

Pipe for the transfer of gas and water.

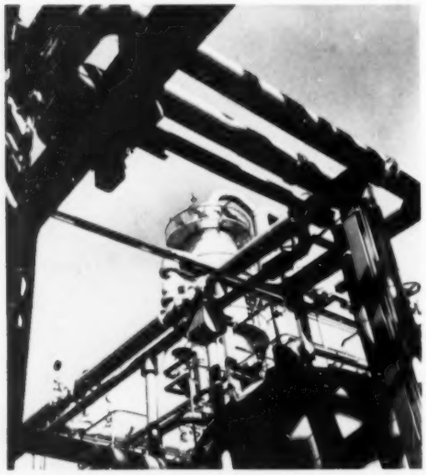
Pipe for domestic purposes (gas, water, heating).

Precision steel pipe for vehicle and machine construction.

Flanged pipe and flanged fittings.

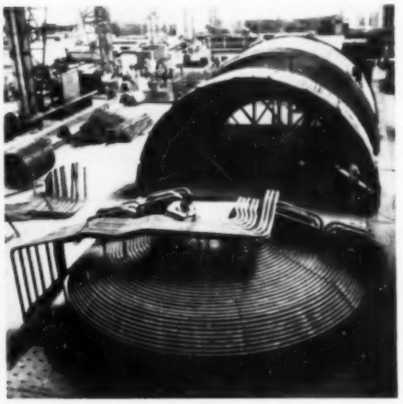
Penstock pipe.

It is not necessary to mention here further types of pipe. The fields



Pipelines in refinery. Photo courtesy Phoenix Rheinrohr AG, Düsseldorf

Pipe coils for a combustion chamber. Photo courtesy Phoenix Rheinrohr AG, Düsseldorf



High Pressure
Containers and Tubes
seamless forged
seamless pressed
seamless drawn
In the Chemical Industry today, the development of Processes has demanded plant construction suitable for high working pressures with either high or very low temperatures.
The requirements of these processes in the fabrication of Containers and Piping neccessitates use of high quality steel, selection of material and fabrication is made from three principal processes in our works, according to each individual unit requirement and operating condition. Our capacity being up to maximum original ingot weight of 120 tons (metric).
Stahl- und Röhrenwerk Reisholz GmbH.
Düsseldorf-Reisholz

OILFIELD SERVICE

Pipes — our Specialty

Confidence — was the basis on which we got first contracts in 1954 and established a new type of oilfield service in Western Germany.

Experience — skill and workmanship made this service an indispensable help to the field engineer.

Reliability — is our best recommendation. Every day many projects are completed without delay.

Economy — is the supreme aim of our planning and is the result of modern methods and uninterrupted work on a wide base.

Capacity — increased to one mile per day (200 miles 1957) of medium-sized pipeline and could be further increased.

Present activity — production lines in 62 gas and oilfields, in addition to gathering, pumping and refining installations. Numerous pipelines are being laid by us.

Additional branches — steel-construction, special-armatures, high-pressure-vessels.

Makers of the new "Wico-Counter," a simple novelty that measures constantly the weight of fluid produced from your wells without separating of gas in closed system—and sends the figures directly to your office if desired for complete automation.

Ask for brochure.

we help — to increase production
— to reduce loss of time and money
— to develop efficient methods of production and field-installation.

we can help you, if you give us a chance to prove our service and give us your confidence.

WINTER & CO. OILFIELD SERVICE

Quakenbrück — Germany

Telex 094426 **Phone 721** **Box 117**

Above: Shipment of a large pipe (length about 160 feet) Photo courtesy Hoesch Export GmbH, Dortmund

Left: Transfer pipelines in a tank yard. Photo courtesy Friedrich Uhde GmbH, Dortmund

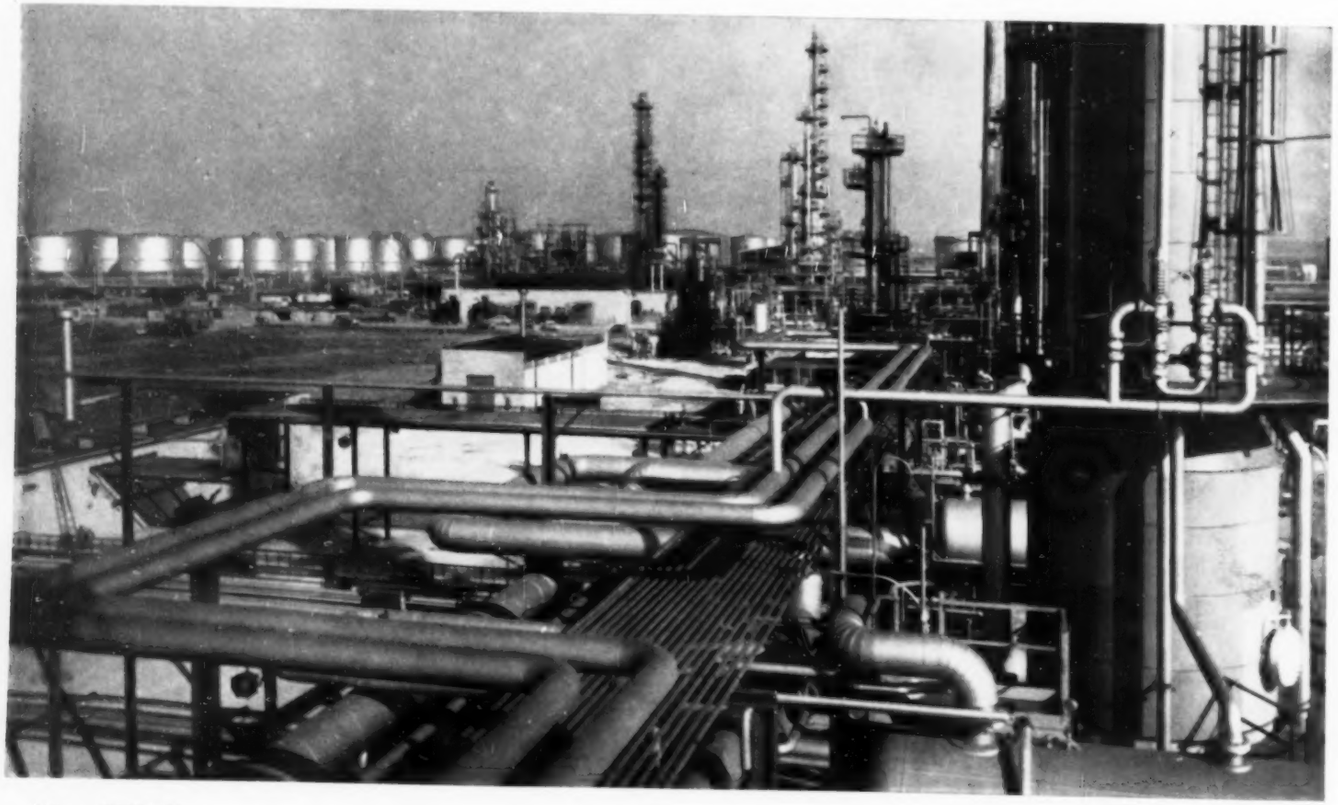
(Continued from page 122)

of application stated above clearly show that pipe for each possible purpose can be made in all desired dimensions and of material as required.

Notwithstanding manifold application possibilities the use of pipe as line pipe predominates. Many millions of miles of pipelines are distributed all over the world. This refers not only to long distance pipelines, although these constitute a major part of this world pipeline system, but also to the many supply and distribution lines in communities and industrial plants. In large industrial plants hundreds of miles of pipelines run in all directions throughout the whole of the plant. Operating reliability depends to a large extent on the proper functioning of this pipeline system. For that reason the laying out of pipelines and their correct installation is given particular attention.

About a year ago an installation for automatic welding of spiral pipe began operations in order to supply the steadily increasing demand for pipe of large diameters. In this installation pipes of a diameter up to 60" are manufactured by means of the Union Melt welding process applied on two sides. In this manufacturing procedure a squared wide band is shaped in a sleeve to the pipe and welded on the inside and outside according to the Ellira welding process. For large size pipe, this procedure has appreciable advantages since sheet metal bands of the same width can be used for the manufacture of pipe of different diameters. Furthermore, this spiral pipe process permits the manufacture of pipe of the largest diameter with the smallest wall thickness in a continuous operation. The properties of pipe manufactured according to this process are extremely favorable since material with better properties lies in the direction of the main stress of the pipe.

Piping system of a refinery in West Germany near Cologne Photo courtesy Friedrich Uhde GmbH, Dortmund



Welded
High-pressure-pipes

Pipe-lines

Overland-lines
for gases and liquids

Rinsing-tubes

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VRB

Piping the oil ways
wherever they are to go:

That's VRB—work and—experience on oilfields and in refinery plants.

Ask VRB for planning and constructing. Our experienced engineers are ready for consulting.

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BERLIN · DÜSSELDORF · MÜNCHEN · GERMANY

PHOENIX-RHEINROHR AG

VEREINIGTE HÜTTEN- UND RÖHRENWERKE DÜSSELDORF GERMANY

Our program for the petroleum industry comprises the following products:

DRILL PIPE in all sizes according to API Std. 5 A from 2 3/8" O. D. up to 6 5/8" O. D. with screwed-on, shrunk-on and welded-on Tool Joints

CASING in all sizes according to API Std. 5 A from 4 1/2" O. D. up to 20" O. D. with short and long threads and couplings

TUBING in all sizes according to API Std. 5 A from 1,05" O. D. up to 4 1/2" O. D. non-upset and external-upset

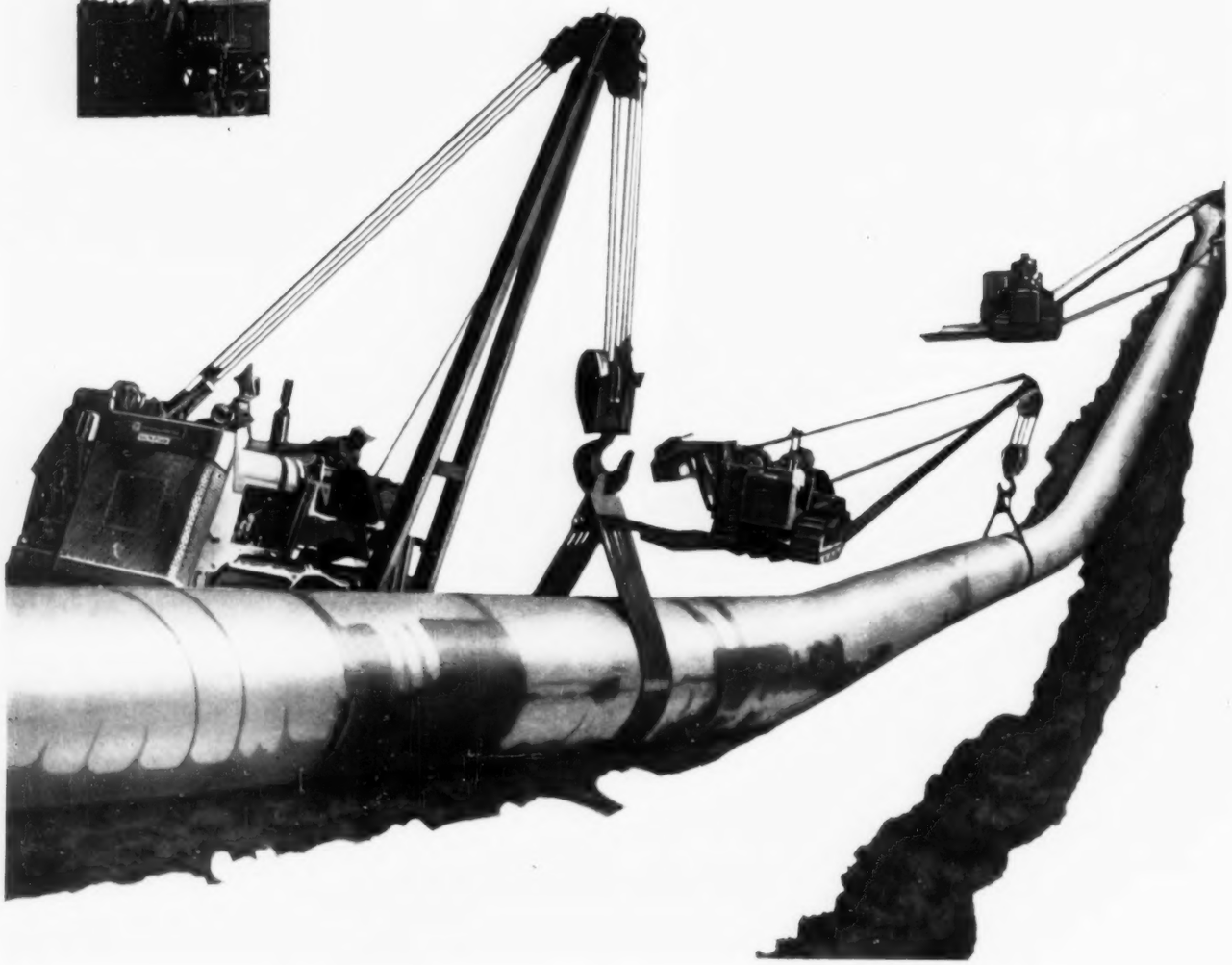
LINE PIPE in all sizes according to API Std. 5 L and 5 LX from 1/8" Nom. Size up to 36" O. D. seamless and welded

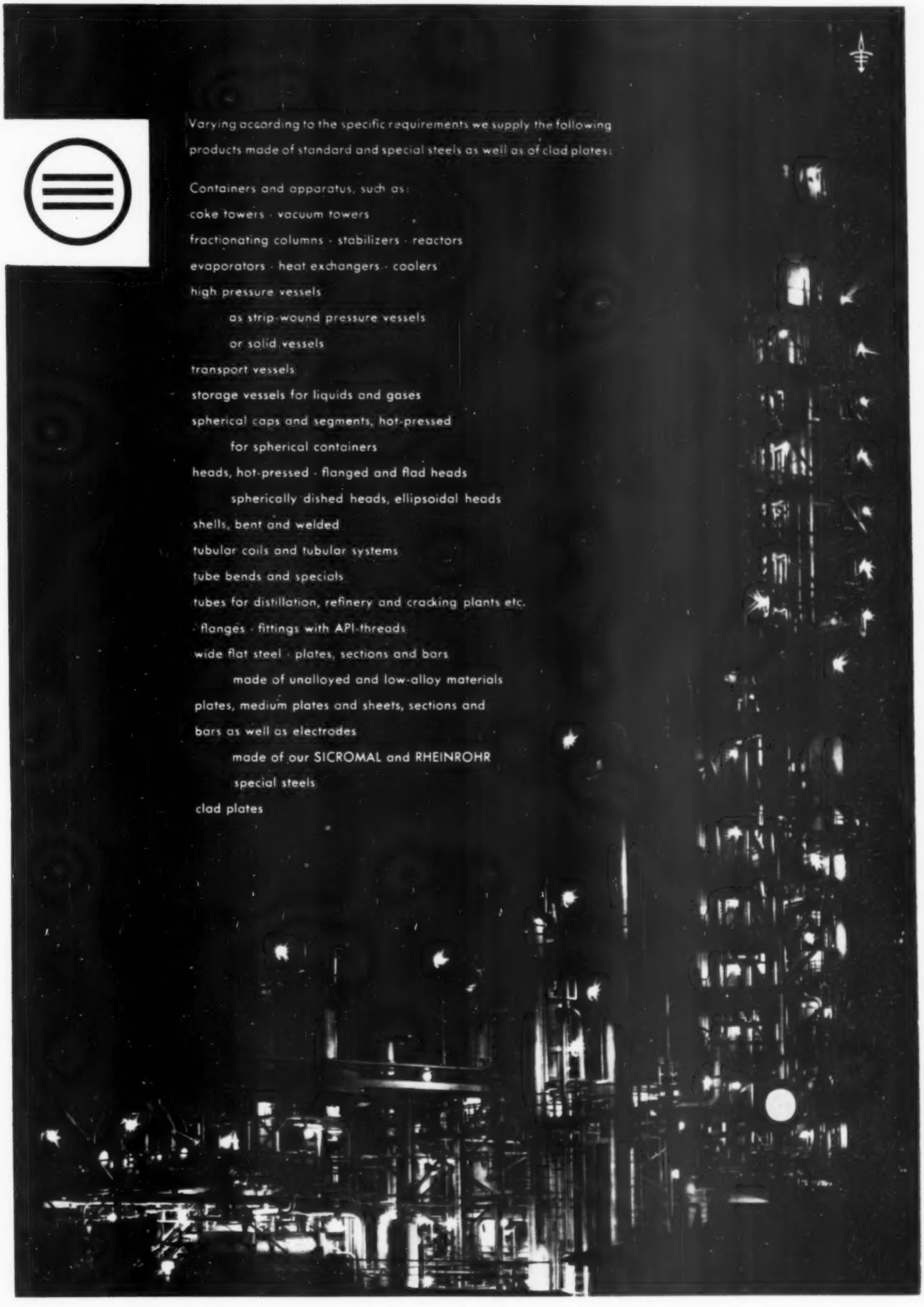
PIPE FOR DISTILLATION PLANTS, CRACKING PLANTS ETC. in all sizes for all stresses

STEELS: all normal API grades as well as special steels for maximum stresses

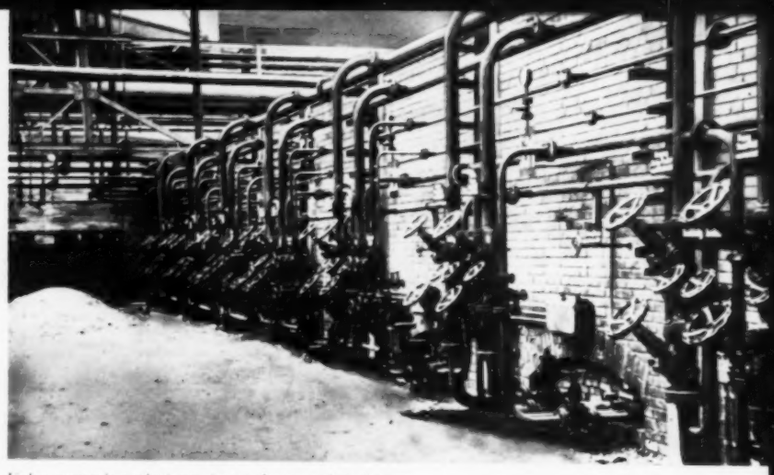
SPECIALTY CASING and TUBING with **OMEGA-JOINTS** with extremely high joint strength

Demand our special catalogues




Varying according to the specific requirements we supply the following products made of standard and special steels as well as of clad plates:
Containers and apparatus, such as:
coke towers · vacuum towers
fractionating columns · stabilizers · reactors
evaporators · heat exchangers · coolers
high pressure vessels
as strip-wound pressure vessels
or solid vessels
transport vessels
storage vessels for liquids and gases
spherical caps and segments, hot-pressed
for spherical containers
heads, hot-pressed · flanged and flad heads
spherically dished heads, ellipsoidal heads
shells, bent and welded
tubular coils and tubular systems
tube bends and specials
tubes for distillation, refinery and cracking plants etc.
· flanges · fittings with API-threads
wide flat steel · plates, sections and bars
made of unalloyed and low-alloy materials
plates, medium plates and sheets, sections and
bars as well as electrodes
made of our SICROMAL and RHEINROHR
special steels
clad plates

4 Valves and fittings



Valve operating platform for underground tanks. Photo courtesy Friedrich Uhde GmbH, Dortmund

THE reliable operation of a refinery depends to a large extent on the proper functioning of the valves connected to equipment and machines or installed in the interconnecting pipelines. These valves are required for starting-up, the changing of operating conditions and shutting down of the plant. Since this field comprises so many different types like globe valves, gate valves, cocks, throttle valves, back pressure valves, check valves, safety valves, 2-way valves, 3-way valves, block valves, control valves, relief valves, purging valves etc. proper application always constituted a broad field of activity for engineer and designer.

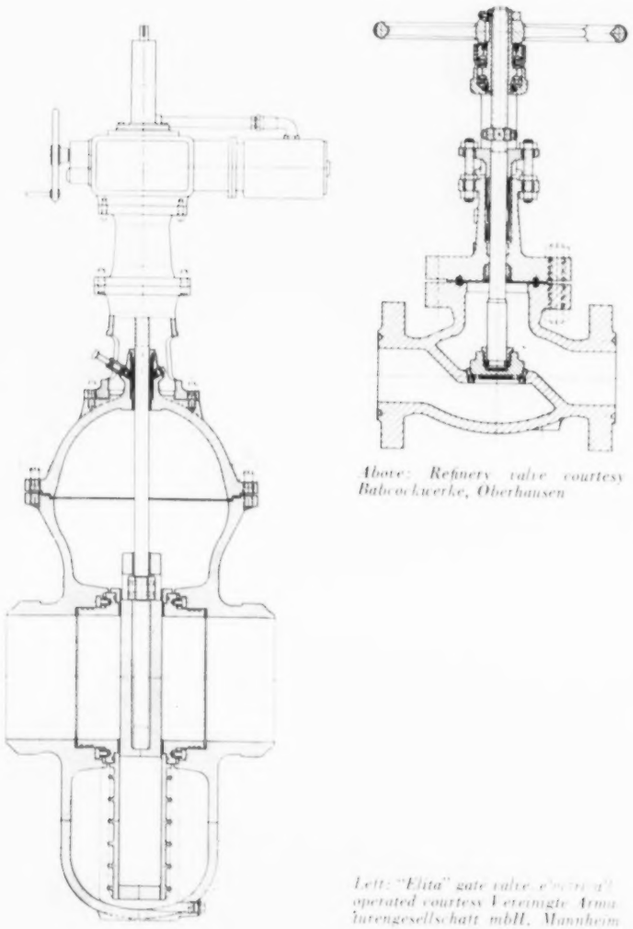
Refinery operations put particularly stringent requirements on these pieces of equipment with regard to reliability, operating safety, maneuverability and facility of inspection whereby of course the normal requirements of minimum flow resistance, suitable stem arrangement, center of inlet and outlet at the same level, easy adjustment of the stuffing box, secured installation of the flange gaskets etc. must be met.

Often these valves must be actuated by remote control, automatic control or in view of appreciable stem adjusting power due to high operating pressures and too large diameters, by auxiliary drives such as electric motors, Servo motor, compressed air motor etc. The numerous types of automatic devices like float valves, back pressure valves, solenoid valves etc. may be mentioned here. Steam traps may also be referred to in connection with the installation of steam lines. Aside from these various devices which are all used for definite control and diversion purposes, pipeline fittings such as pipe bends, elbows, tees, branch pieces, reducers, flanges, sockets, expansion joints and articulated compensators are also used to a large extent and in many different ways.

The present shop technique enables the manufacture of the devices in series and still guarantees a tight seal between cone and seat of the valve. In actual operation more severe requirements are placed on these devices not only on account of high pressures and temperatures but also with regard to the tightness of the valve and the stuffing box material since these are subjected to the attack of mechanical and chemical impurities entrained by all products carried through pipelines regardless whether they are liquids or vapors. Exchangeable seats, adjustable stuffing boxes, back stops at the stems are, therefore, indispensable requirements for modern piping systems.

Often thick pastes, viscous liquids and easily congealing products flow through valves which then have to be provided with jackets for heating with steam, hot air or hot water or to be equipped with an electric heating coil. Those devices which must dependably be operated under hot operating conditions are provided with cooling chambers, cooling ribs, extended and cooled stuffing boxes.

In order to choose for plant operation, the most modern dependable and reliable devices for each purpose and for each location an appreciable amount of know-how is required for the proper selection of the numerous types and large number of piping devices necessary for a refinery. The complexity of this field with regard to supply and to application is so great that only a few problems can be indicated here. It is impossible to fully cover the problem of valves and fittings in the scope of these considerations about the role which the technique plays in crude oil processing although their application in the field of the petroleum section represents only a modest part of the role they play in all other areas of process technique and operation.



Above: Refinery valve courtesy Babcockwerke, Oberhausen

Left: "Elita" gate valve, electrically operated courtesy Vereinigte Armaturengesellschaft mbH, Mannheim

Modern pipeline devices

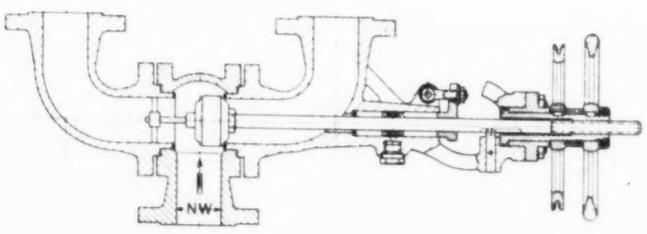
An innovation which is welcomed by consumers in Germany and abroad is the new interconnected two-way valve of the Phönix Armaturen-Werk Bregel KG, Frankfort/Main. The technical inspection offices do not allow the use of normal block valves ahead or back of safety valves. On the other hand it is essential that in case a vessel is protected by two safety valves inlet and blow-off side of each of these can be simultaneously blocked. For this purpose interconnected two-way valves are used.

The interconnection calls for two-way valves of the same dimensions regardless of the fact that probably the inlet of the safety valve is of smaller size than the outlet. In that case reducers are installed. The two-way valves have rising stems and non-rising chain wheels as well as a hand wheel. The chain wheels are interconnected by means of a somewhat sagging chain.

In this way the two-way valve at the inlet side and the one at

(Continued on page 134)

Interconnected two-way valve of electric steel courtesy Phoenix Armaturen Bregel KG, Frankfort Main



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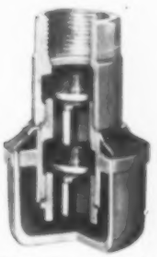
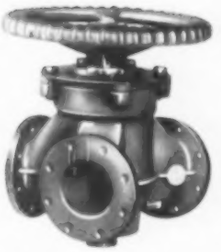


Suction check valve

Quick-acting gate valve



Tank truck draw-off faucet

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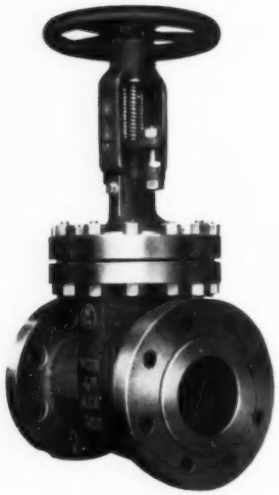
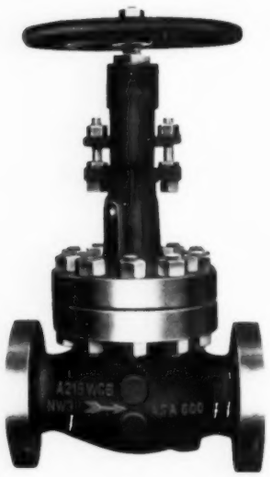
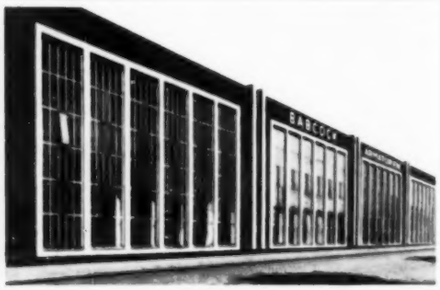


Refinery slide valve serial number 150-1500 NW 2"-24" of unalloyed and alloyed electric cast steel



Refinery shut-off valves serial number 150-1500 NW 2"-8" of unalloyed and alloyed electric cast steel

Refinery slide valves serial number 600-1500 NW ¼"-1½" of forged steel union bonnet and boldet bonnet



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(Continued from page 130)

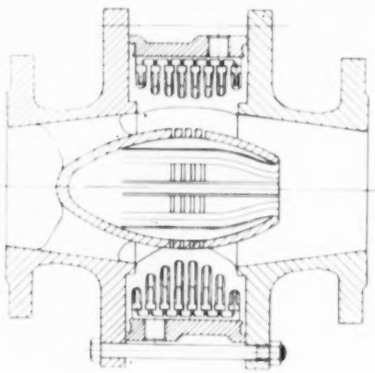
the blow-off side are simultaneously opened or closed by actuating only one hand wheel. In case of a failure of one of the safety valves the inlet two-way valve is reversed. In view of the relatively large force at the periphery of the hand wheel an irreproachable sealing of the relevant seat is obtained. By necessity, the two-way valve at the blow-off side is tightly closed due to the interconnection of the two valves via chain wheel and chain. The use of two-way valves has proven its merits since with this arrangement the vessel is normally protected by two safety valves and always by at least one.

Diaphragm valves:

Entirely deviating from the block devices known and used up to that time new types were developed showing the following remarkable advantages:

1. Guaranteed tightness in the presence of impurities.
2. No possibility of deposits.
3. Noiseless functioning.
4. Can be installed in every position.
5. No stuffing box.
6. Smallest dimensions.
7. Can be used for neutral, corrosive and erosive liquids as well as for gas.

These advantages, guarantee a maximum of operating reliability and these valves practically require no maintenance. The ring diaphragm-block valve of the Eisenwerk H. Schilling is a pneumatically or hydraulically actuated block valve without stuffing box. The actual sealing element is a rubber diaphragm which depending on the nature of the medium (acids, lye solutions, gas etc.) is supplied in different rubber qualities. In case the medium is aggressive or corrosive the inside of the valve is completely provided with a suitable hard rubber lining.



Cross-section of a diaphragm block valve courtesy Eisenwerk H. Schilling, Kracks near Bielefeld

Sealing by means of the diaphragm is done by pushing it against a guide body placed inside the valve casing which body normally does not obstruct the flow of the medium. The pushing of the diaphragm against the above mentioned body is brought about by a pressure impulse caused by compressed air or a liquid under a pressure higher than that of the medium. This sealing is perfect and without folds. Diaphragm, valve casing and guide body are all machined on a lathe. This type of valve can, therefore, be manufactured in extremely small sizes and furthermore obviates any possibility of solid or suspended matter being deposited since all dead spaces are avoided. The diaphragm is so braced to the casing that it cannot be drawn in by vacuum and, therefore, this diaphragm valve can be used for pressure as well as for vacuum operation. The control is by means of a three-way cock which can either be manually operated or by means of an auxiliary force or automatically by remote control. The same company also manufactures in the same way a check valve which due to the use of a ring diaphragm functions noiselessly and without recoil.

At the inlet side of the valve the flange of the diaphragm is firmly fixed to the casing. Due to the shape of the diaphragm its lower end presses against an internal guide body thereby blocking the return passage of the medium. In normal operation the flow of the medium lifts the diaphragm from the guide body and presses it against the internal wall of the casing.

When the feed pump is shut down the pressure of the medium decreases and the diaphragm returns to its original position and presses against the guide body. Therefore, the diaphragm seals before the pressure at the inlet side of the valve is completely released. This means that before a back flow may occur the sealing is present. Neither the block valve nor the check valve of this type contain a stuffing box which otherwise easily leads to leakages and requires maintenance.

Safety valves.

The requirements for safety devices increased with the technical development of petroleum processing plants and petrochemical installations. Amongst these safety devices the purpose of the safety valve is to avoid an undue pressure increase in a plant. In view of the fact that repairs or checking of these valves in most cases cannot be carried out during operation the fulfillment of this task is rendered more difficult. Poorly accessible locations and varying pressure and temperature conditions further aggravate the technical requirements.

Safety valves have to fulfill three essential functions. In the first place during normal operation a safety valve must close tightly. In the second place the intial lift pressure and the full lift pressure should under all circumstances be practically equal. The accuracy tolerance of the safety valve should not exceed that of the usual mechanical and electric measuring instruments.

As a third function in case of undue pressure increase the safety valve must be able to blow off per unit of time a predetermined amount of the medium.

With a view to complying with all these requirements for all different nominal sizes the Sempell company of Mönchen-Gladbach developed a full range of safety valves of which the smallest one has a minimum free-flow cross section of 137 mm² and the largest one a cross section of 5700 mm². These safety valves can be manufactured in all required material qualities in open or gastight construction. All valves have a high coefficient of discharge, namely $\alpha = 0.93$. Practically all construction include an adjusting ring for the precision adjustment of the tolerance. In principle, these gas tight valves correspond in their construction to the well known full lift valves used for a long time in refineries in which the seat of the valve is nozzle like contracted in area.

A particular feature of these valves is the use of a stopper which is screwed into the lower spring retainer and by means of which the spring tension can be accurately adjusted. This device results in the possibility of a more accurate adjustment than can be obtained with normal helical springs with spring retainers on both ends. In connection with this improvement various adjusting rings for the precision adjustment could be omitted which considerably simplified the maintenance and the adjustment of the valves. These valves have been used in most of the German refineries and chemical plants for a number of years.

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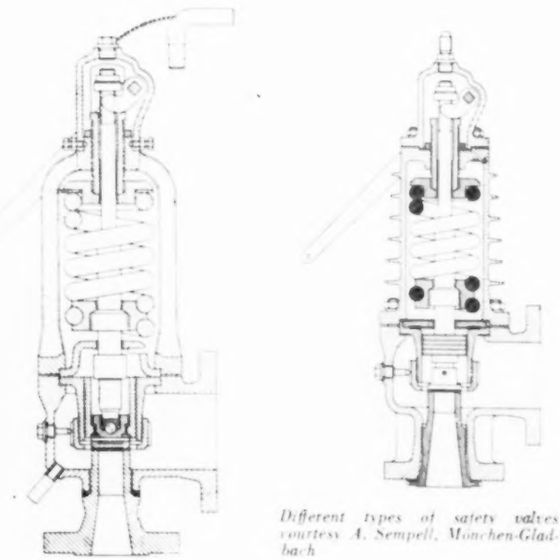
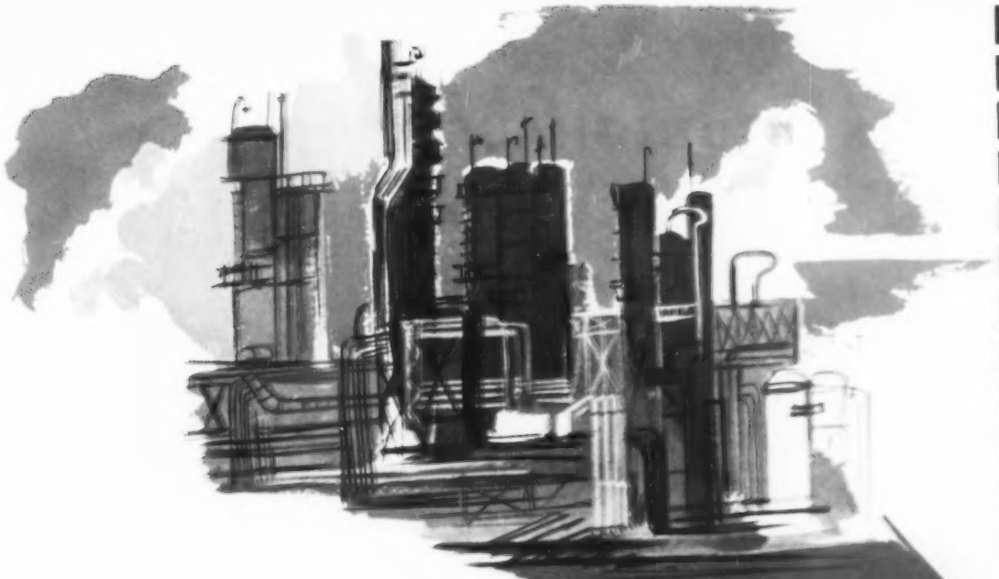


Different types of safety valves courtesy A. Sempell, Mönchen-Gladbach



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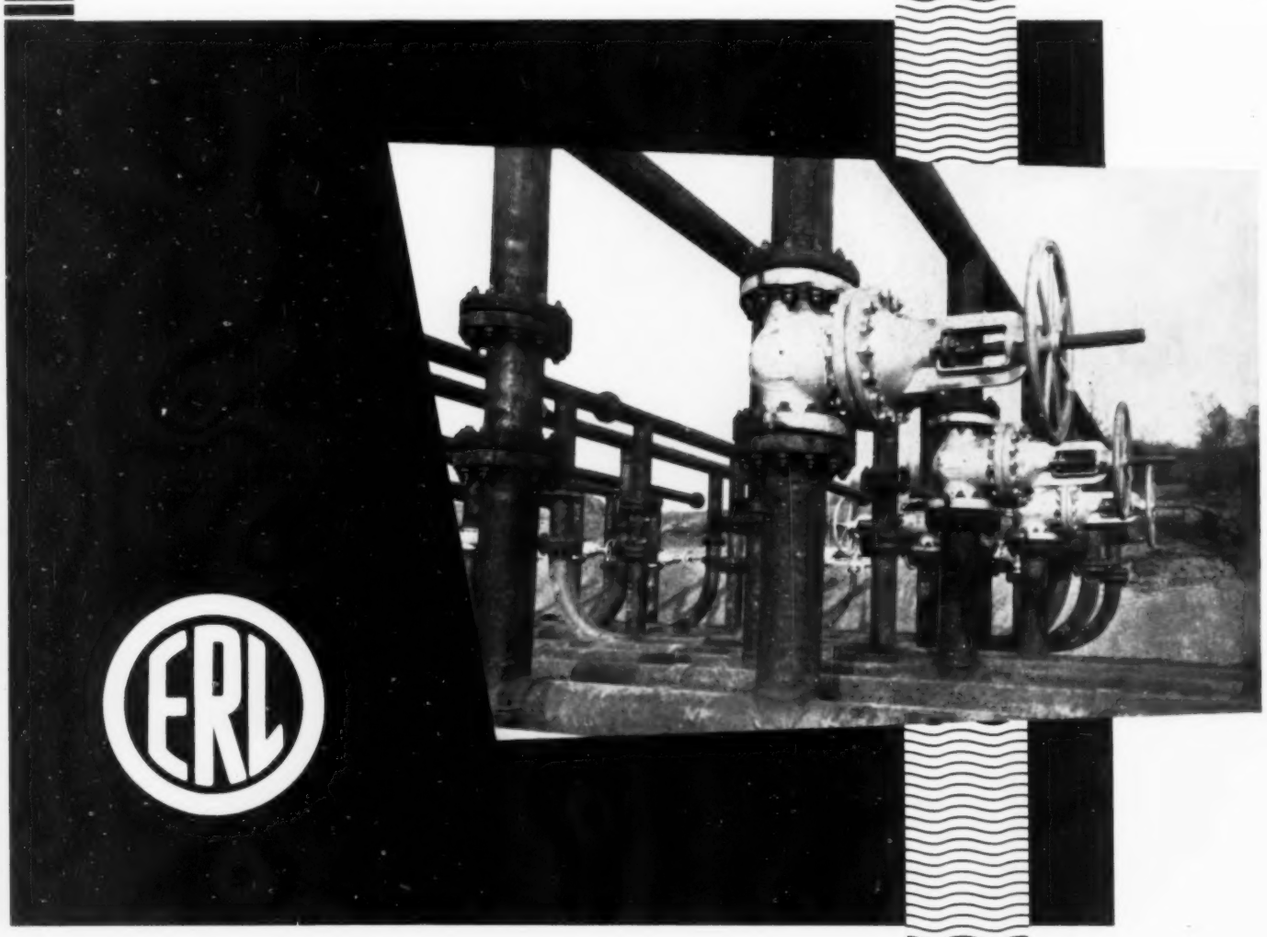

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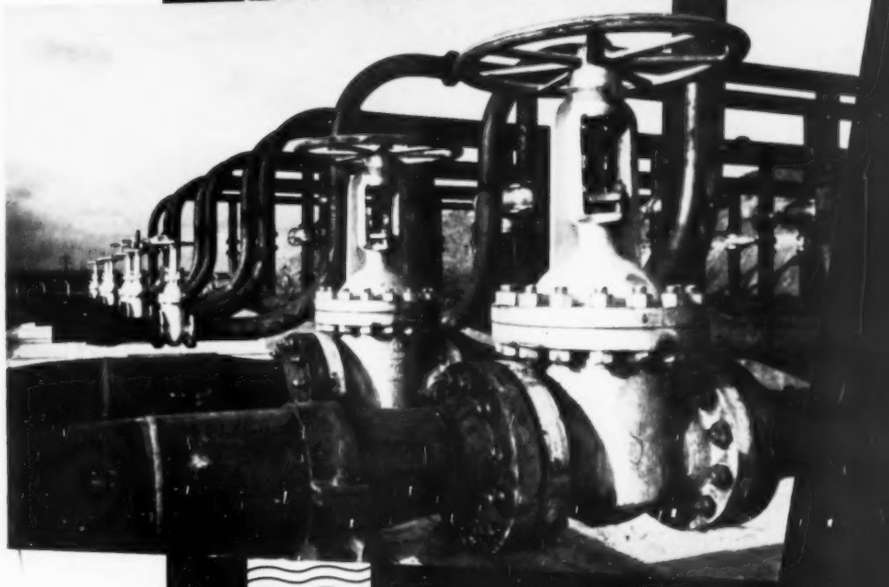

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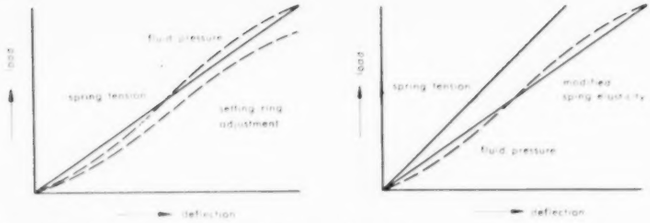


Forces resulting from flow through an opened safety valve. Charts courtesy A. Sempell, München-Gladbach

(Continued from page 134)

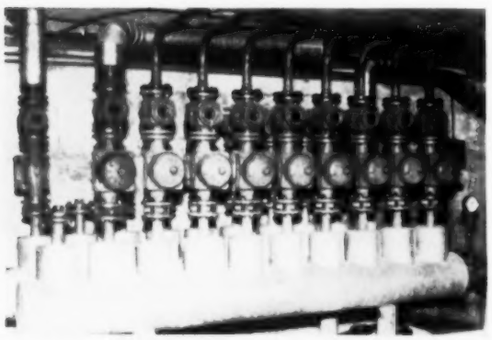
Steam traps.

In many places in a refinery steam is required as thermal energy. In those countries in which this form of energy can be cheaply generated no particular value is attached to the economic utilization thereof. However, in Europe the price of fuel and the cost of generating steam are rather high so that under these circumstances aside from the desire to safeguard production, particular attention has been paid to economy. Both are served by installing a properly functioning condensate collecting installation in the plant steam system. Only such an installation can guarantee the maintenance of the required technological conditions on which the production of the various fractions is based. Generally speaking, an open condensate system is used in the case the cost of heat energy is low. Such a system comprises condensate removal from the individual steam consumer with a free discharge to the atmosphere. This, however, may easily lead to inconveniences in places where the climatic conditions are such that appreciable humidity exists. A closed system does not give rise to such inconveniences.

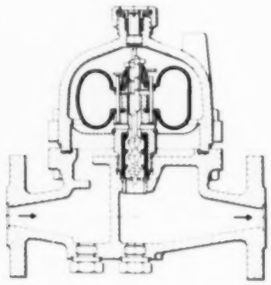
Steam trap in oil field. Photo courtesy Gustav F. Gerdts KG, Bremen

using the proper system with sight glasses a condensate system can be centrally supervised and controlled. With the aid of the built in "Vaposkope" oil leakages of the pertaining heating surfaces can be immediately noted. German industry manufactures for all possible purposes and for the most extreme climatic conditions condensate systems which function economically and comprise first class equipment of the required dimensions and capacities.

In this connection we should like to refer to the relevant plant photos of the following companies: Gustav F. Gerdts KG, Bremen and Gustav Mankenberg, Lübeck. High class fully automatic steam traps further the automation in the petroleum industry and can be



Centralized steam trap installation with sight glasses. Photo courtesy Gustav F. Gerdts KG, Bremen



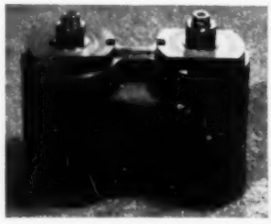
Cross-section of a steam trap with bimental control courtesy Gustav F. Gerdts KG, Bremen

High pressure steam trap, nominal pressure 400, t = 600° C (about 1100° F). Photo courtesy Gustav Mankenberg GmbH, Lübeck

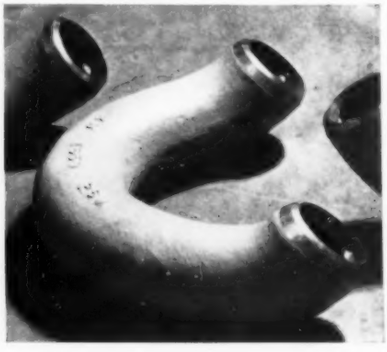
Heat losses incurred with an open system may amount to 30%, and furthermore, steam formation leads to poor visibility and ice-formation with increased possibility of accidents. Moreover, air and moisture will be unavoidably absorbed by the condensate and in this way increased corrosion and fouling of the system will occur. On the other hand a closed system does away with corrosion and fouling of heat exchange surfaces and pipes since no air can be taken up. This in turn results in an easier control of the production conditions, a longer life of pipelines, valves and fittings, less maintenance, fewer repairs, higher capacity and uniform product qualities.

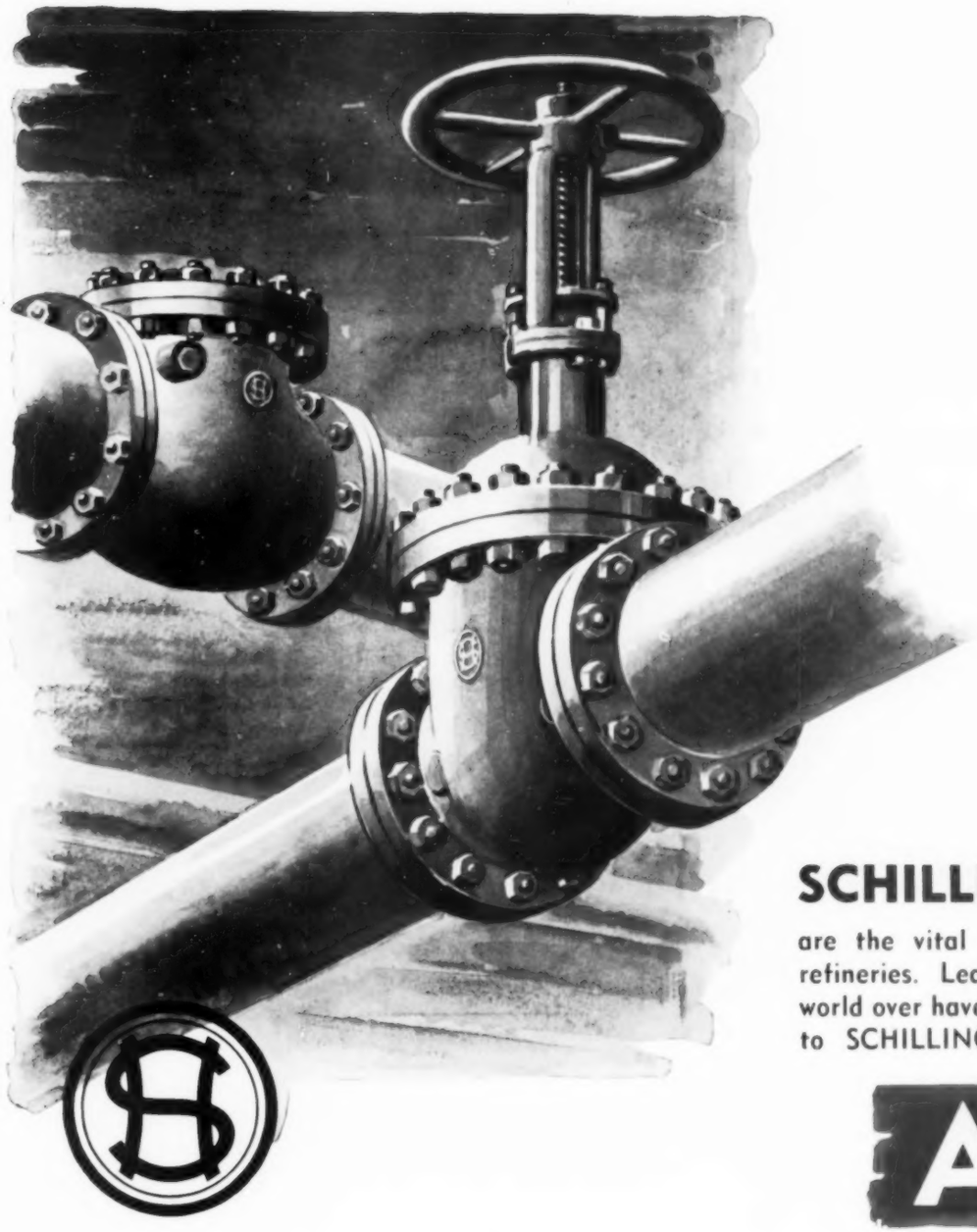
Collecting of condensate in a closed system leads to additional heat savings and obviates the necessity of installing special boiler feed water facilities. However, the closed system requires the installation of dependable steam traps which can be used for a long time, do not require any maintenance and function in a reliable way. Steam traps are not affected by dirt, deaerate automatically and uninterruptedly function properly. They furthermore avoid heating surface damage due to vacuum formation upon temperature reduction. Thermodynamic and thermostatic steam traps (with DUO steel for the thermal control) not only guarantee an irreproachable production but also a smooth operation even in case of cold weather, sudden temperature drop and extreme climatic conditions. When kept in uninterrupted operation for a period which at least equals that of the production plants so that operating interruptions due to a shorter repair cycle do not occur.

(Continued on page 143)



Return bends. Photo courtesy Bergische Stahlindustrie, Remscheidt





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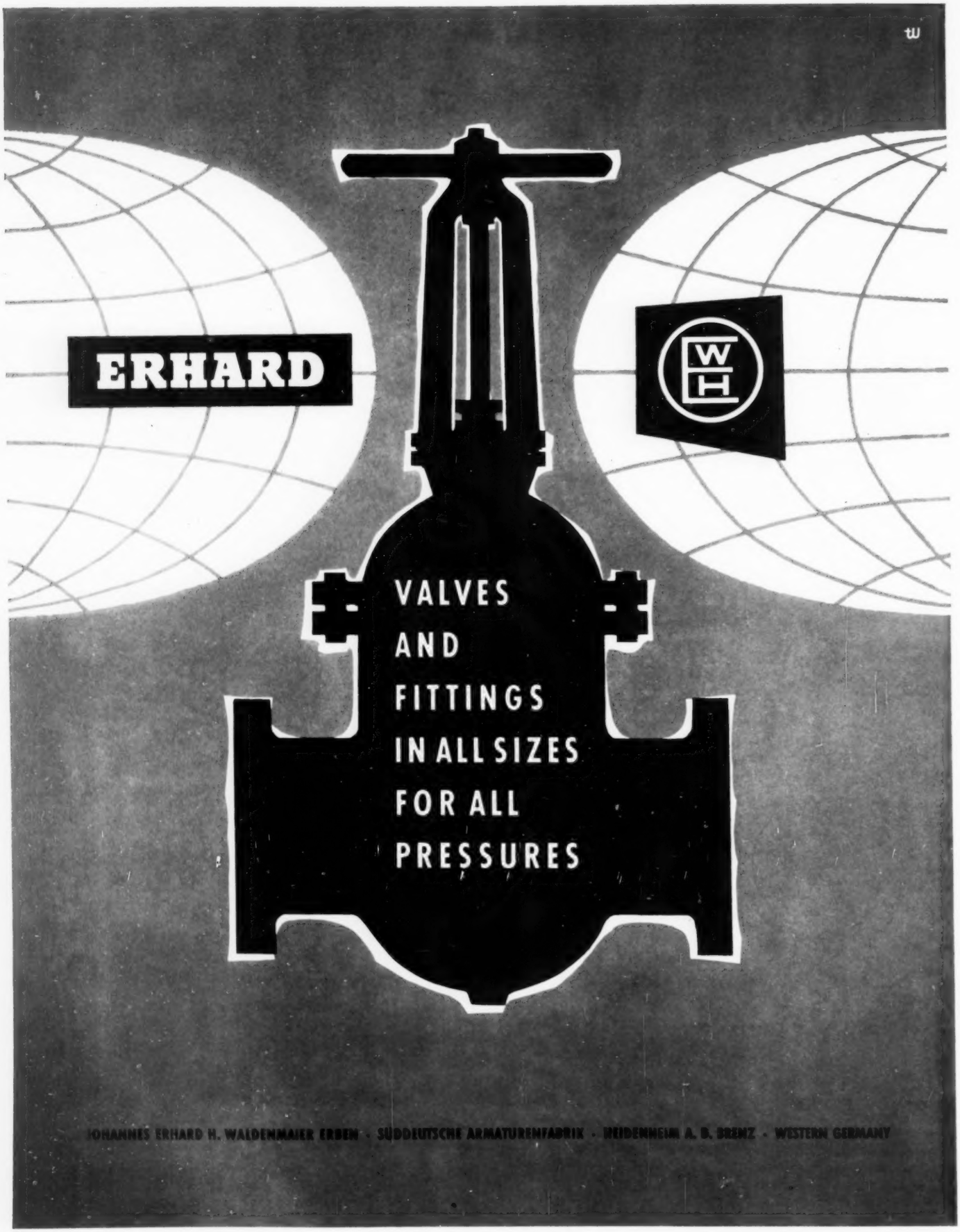
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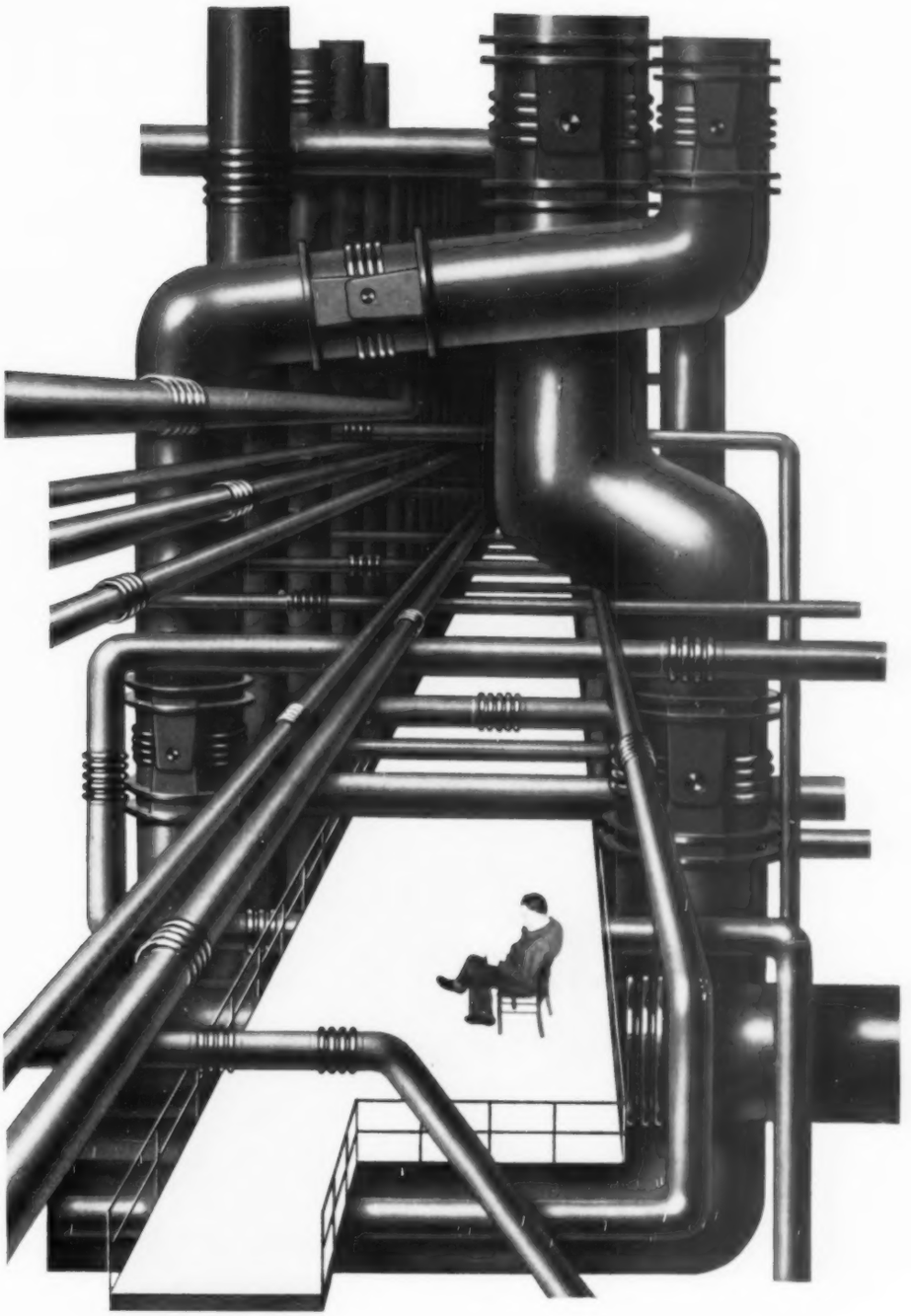

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Magnetically operated liquid level indicators Interface indicators Refinery valves and fittings (DIN and ASA standards)

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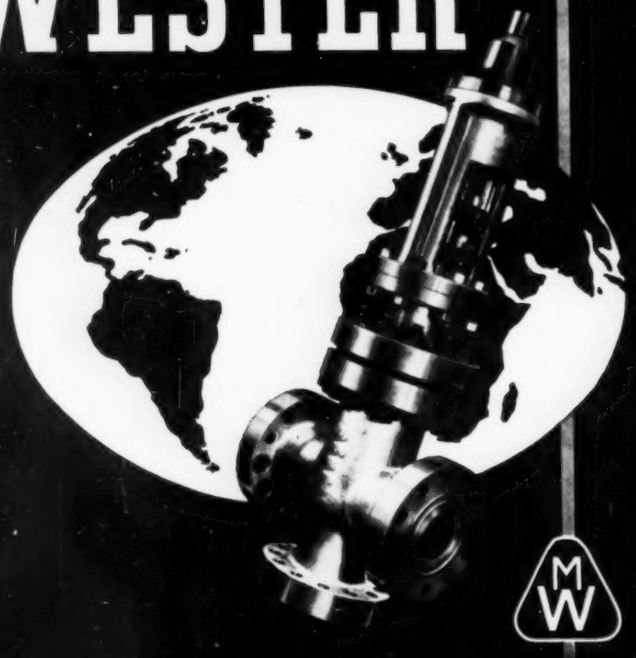

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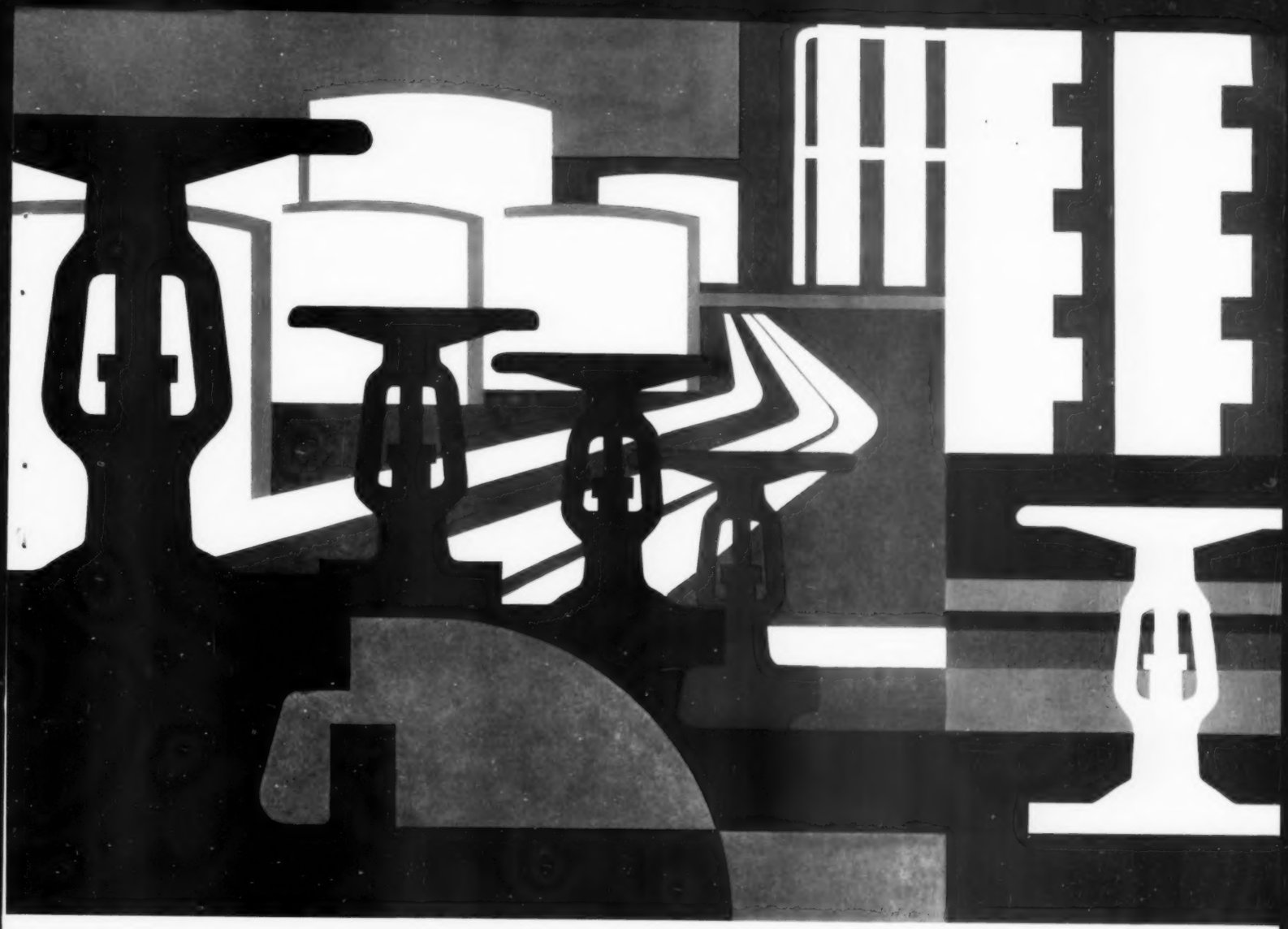

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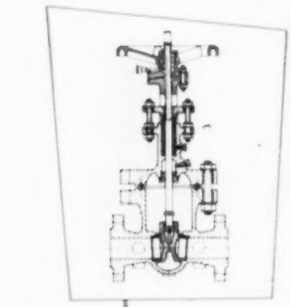

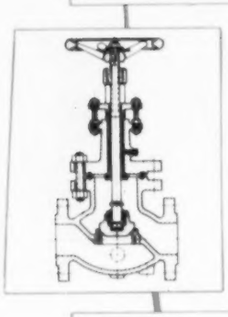

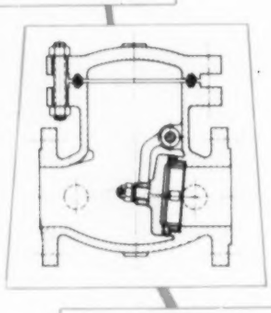

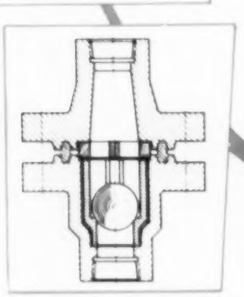

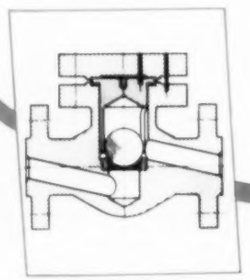

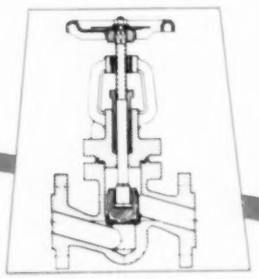

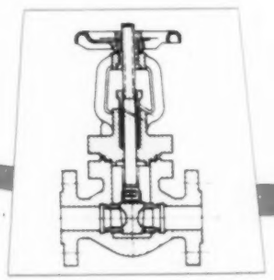

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STRACK

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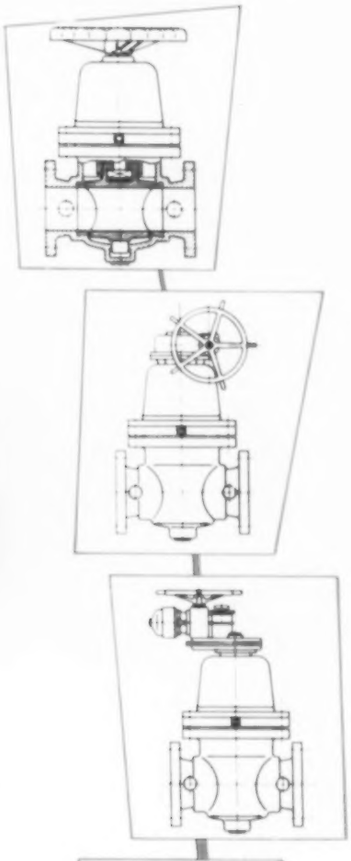


The operation of **STRACK** lift plugcocks shown above is similar to that of the usual plugcock but here the plug is slightly liftet befor turning.

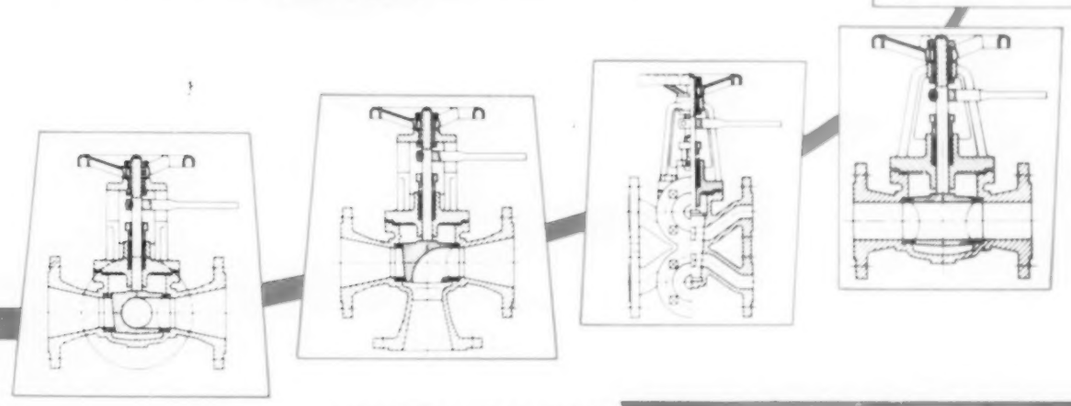
The essential improvements are the following:

a) All seats are of high resistant materials (For gas services etc., body seat rings are made of plastic material, such as teflon etc.)

b) **STRACK** lift plugcocks require no maintenance.

c) They are available with motor-operation (either electric or pneumatic), or hand-operated. In one motion, the plug is lifted from the seat, turned and automatically reseated.

More than 300 000 **STRACK** lift plugcocks are now in service.



TROISDORF BEZ. KÖLN
GERMANY

ARMATURENFABRIK JOSEF STRACK GMBH

(Continued from page 138)

Fittings.

Wherever plants for the processing of petroleum exist or are being built the attenion of the observer will be immediately drawn to the tubular heater as one of the outstanding plant parts. *Refinery fittings* constitute an essential element of these tubular furnaces in which various types of these fittings are used.

1. *Headers.* These are installed in those furnaces in which a cleaning of the tubes must be possible in view of an eventual tube coking. This may be the case in petroleum distillation furnaces and in cracking furnaces.

2. *Return bends.* These have no clean-out holes and can, therefore, only be used if a coking of the tubes is not to be expected.

Depending on the type of furnace construction and tube arrangement various forms of refinery fittings are used, e.g. jump-over headers, jump-over bends, multiple hole bends, pipe elbows and others. For safety reasons in connection with high operating pressures and temperatures, refinery fittings are now provided with self-sealing plugs. In this case the internal pressure brings about the absolute tightness of the plug seal.

Recent developments in petroleum technology have placed steadily more stringent requirements on refinery fittings. These castings must often withstand very high pressures, temperatures and in addition thereto the attack of the various media. On top of that many a time special requirements are to be met so that aside from the large selection of conventional types of elbows and bends to be kept on stock special fittings have to be manufactured to meet extraordinary operating conditions and extreme service requirements in connection with corrosion and erosion.

In view of these special requirements all parts have to be made of high-grade alloyed or unalloyed electric steel in order to meet the various operating conditions; furthermore always special inspection regulations have to be considered. An irreproachable manufacture of refinery fittings is guaranteed by carrying out a number of tests during and at the conclusion of the fabrication like x-ray and other nondestructive tests (Magnaflux and Organol process) pressure tests with air, steam, water and kerosine. In a word, the utmost care and vigilance are exercised during the manufacture of refinery fittings as is due these important elements of tubular furnaces.

Expansion joints and articulated compensators.

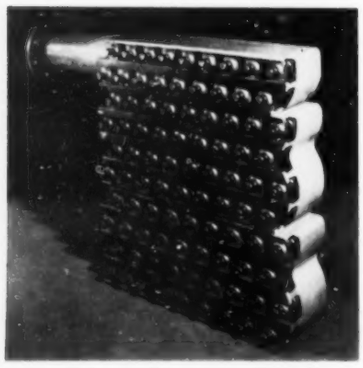
Due to internal and external temperature influences temperature variations occur in all pipelines on account of which these pipelines contract and expand. Wherever these variations in length cannot be taken up by the natural flexibility of plain pipe the installation of expansion joints is required. The Industrie-Werke Karlsruhe AG manufactures for pipelines different steel bellows-type expansion joints without stuffing boxes. The special features of these expansion joints are: high absorption of expansion, small space requirement and only slight stresses on the pipeline.

When determining maximum permissible change in length, consideration should be given to the fact that possibly the pipline may be out of service during winter. In particular with regard to pipelines which will be located in the open, the lowest winter temperature should be used for calculations.

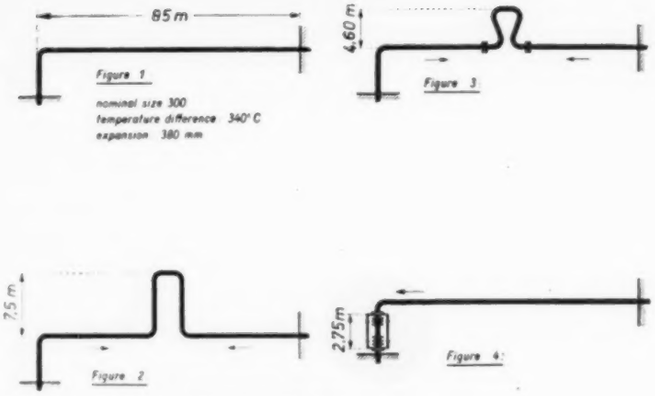
As an example, a line with a length of 85 m (about 280 ft) and a maximum temperature difference of from −10 C (14 F) to +330 C (626 F) the pipe expansion amounts to 380 mm (about 15 in.). The space conditions are decisive for the selection of the most suitable expansion joints. For the above example and a line diameter of 300 mm (12 in.) a plain pipe U-bend with a length of overhang of 7.5 m (about 25 ft) would be required whereas a commercial-type Lyre bellows bend with an overhang of only 4.6 m (about 15 ft) would be necessary. For the same conditions an IWK articulated compensator with an overhang of 2.75 m (about 9 ft) would suffice which in many cases could be installed in the pipe system without requiring any special space.

When pipes are laid in streets in narrow ditches the use of articulated expansion joints is often not possible. In this case axial compensators must be applied. Chrome molybdenum steel is used for compensators up to 400 C (about 750 F); after annealing this alloy has a yield point of 45 kg/mm², an elongation of 16% (L = 5 d) and a creep limit of 26 kg/mm² at 400 C (about 750 F). At temperatures above 400 C the high temperature stability rapidly decreases. For that reason a chrome nickel steel with about 18% Cr and 8% Ni is used for higher temperatures. Welding ends, internal guide tube and flanges are normally made of mild steel, but in special cases of fire or acidproof steel.

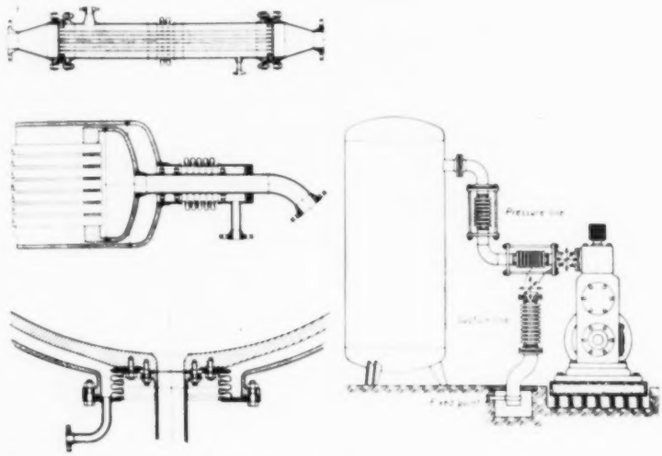
Articulated compensators serve the same purpose. Their functioning is also based on angular movements of the steel bellows. However, in the case of articulated compensators these are combined in a special arrangement so that no additional load worth mentioning of the fixed points of the pipelines occurs. Further details can be noted from the IWK diagrams.



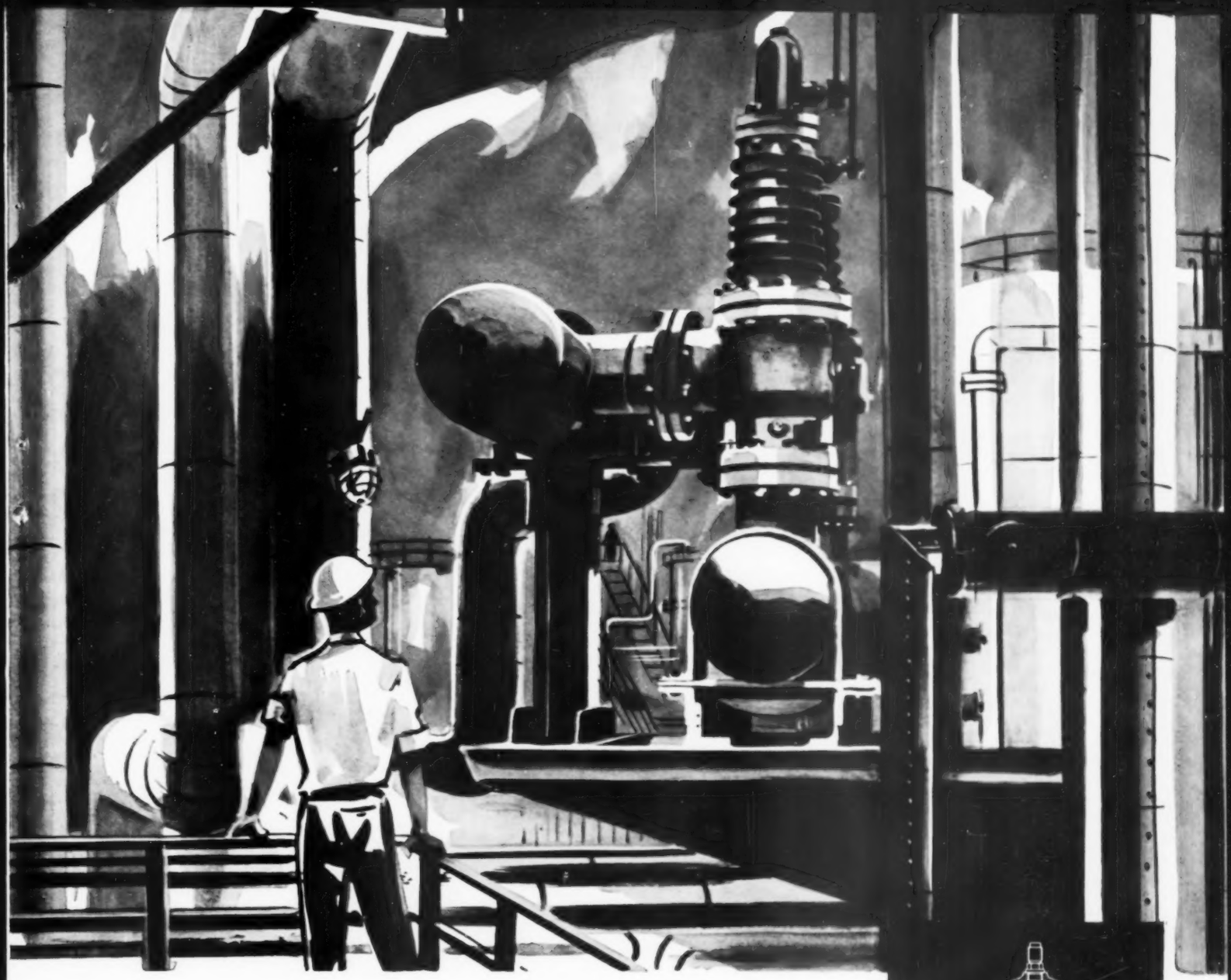
Header box. Photo courtesy Bergische Stahlindustrie, Remscheidt



Scheme of an expansion joint courtesy Industrie-Werke Karlsruhe AG, Karlsruhe



Various installation methods of expansion joints courtesy Industrie-Werke Karlsruhe AG, Karlsruhe



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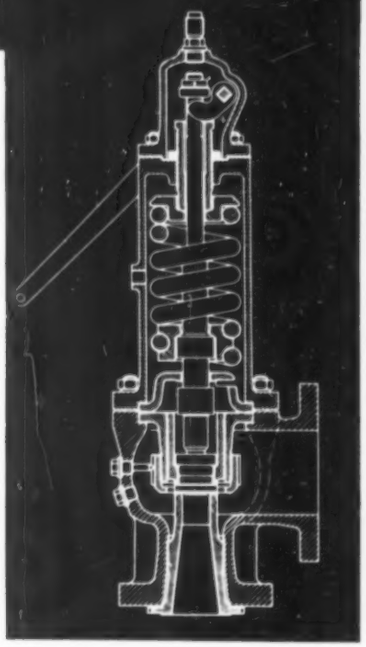

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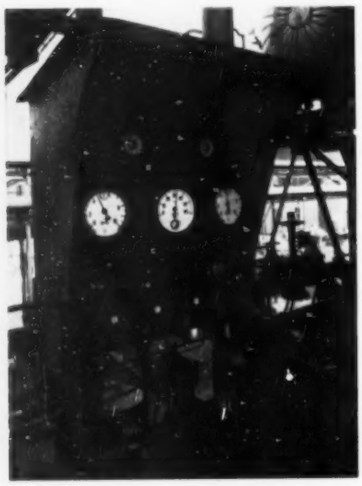
5 Measuring and control instruments

COMPARED with the impressive towers, equipment and piping systems of a modern, chemical plant or refinery the small building housing the instrument room appears quite insignificant and yet to a certain extent it represents the "brains" of the plant. The operation of the plant is controlled with the aid of devices mounted on the instrument board; from this center the pneumatic and electric lines transmit control and regulating impulses to valves and motors which either unpretentiously distributed or combined to batteries determine the flow of products and utilities.

From the early stages of project work a close cooperation between process engineer, instrument engineer and instrument manufacturer is required in order to ensure that the range of control meets the process requirements. However, the final decision as well as the overall responsibility rest with the engineering company. It is its task to combine process equipment and control systems into a harmonious unit. Its planning on the strength of general experience will be supplemented by the suggestions of the measuring and control instrument manufacturer with regard to the type of instrument and the method of installation. The wishes of the engineering company induce the instrument manufacturer to steadily improve his instruments and to devise new types to cope with new problems. The suggestions and the constructive criticism of the customer show the manufacturer in which way improvements should be made. On the other hand, newly developed measuring and control instruments may give rise to new possibilities of operating control.

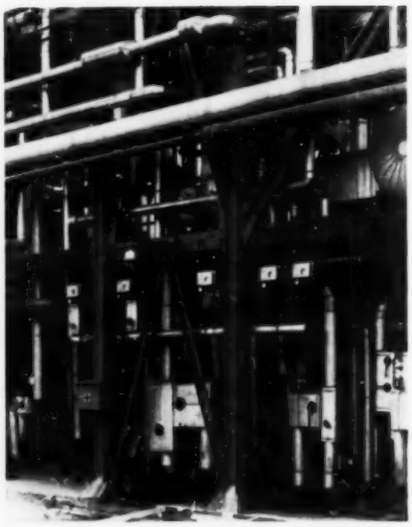
This correlation of problem and solution, of proposal and practical application is based on the confidence existing between engineering company and instrument supplier. This close cooperation is still further required during the installation of the measuring and control instruments. Even when a group of instrument manufacturing specialists carries out the complete installation it still will be advantageous, in particular in less industrialized countries to have experienced special mechanics available for supervision and for training of the local personnel. If requested, the instrument manufacturer will leave his personnel for further supervision also after the plant has been completed. Special maintenance men will regularly check the instruments. Selected personnel of the customer can be given a training course in the care of instruments and in the carrying out of minor repairs. This may be in the manufacturer's shop or by means of an instrument course.



Plant measuring instrument panel. Photos on this page courtesy J. C. Eckardt AG, Stuttgart-Bad Cannstatt

Thus, the engineering company and the instrument manufacturer work together closely from the beginning of the planning up to the time the plant is placed in operation. Although later on the engineering company may retire to the background it is good to know for all concerned that everything has been done to ensure an irreproachable operation of the plant for a long time to come. In modern industrial plants the two concepts of measurement and control are inseparable. It is the task of the measuring technique to visually indicate all operations and the technological condition of the production process.

For an effective supervision of operation it is in most cases indispensable to record continuously or periodically the actual operating conditions in addition to the readings of the indicating instruments. For an adequate supervision of the quality of products the recording of these data by hand insertion on the operating sheets does not suffice. For that reason nowadays all important readings of temperature, pressure level indication, flow, flow velocity, humidity, electric conductivity, composition of gas and liquid are continuously recorded or metered.



Plant installation of remote controls

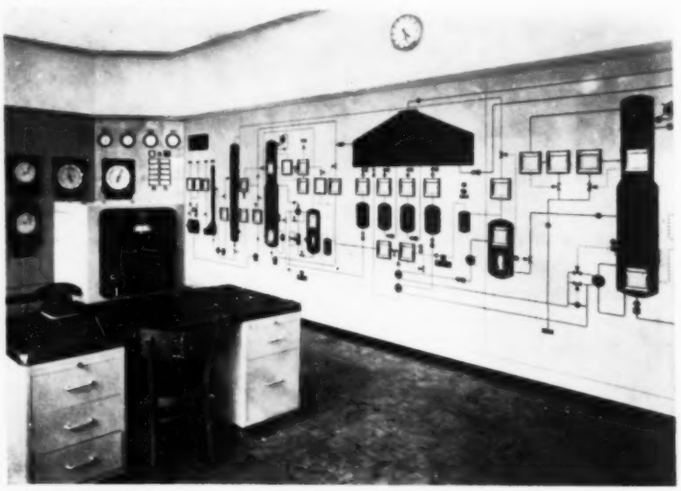
A modern fully automatic plant without recorders, recording meters and alarm devices is not conceivable. Furthermore, the manufacture of instruments and installations for the measuring of electrical units also represents an appreciable section of the measuring technique, since electrically driven prime movers and machines play such an important part in a refinery. This section of the measuring technique is, therefore, divided in two main parts:

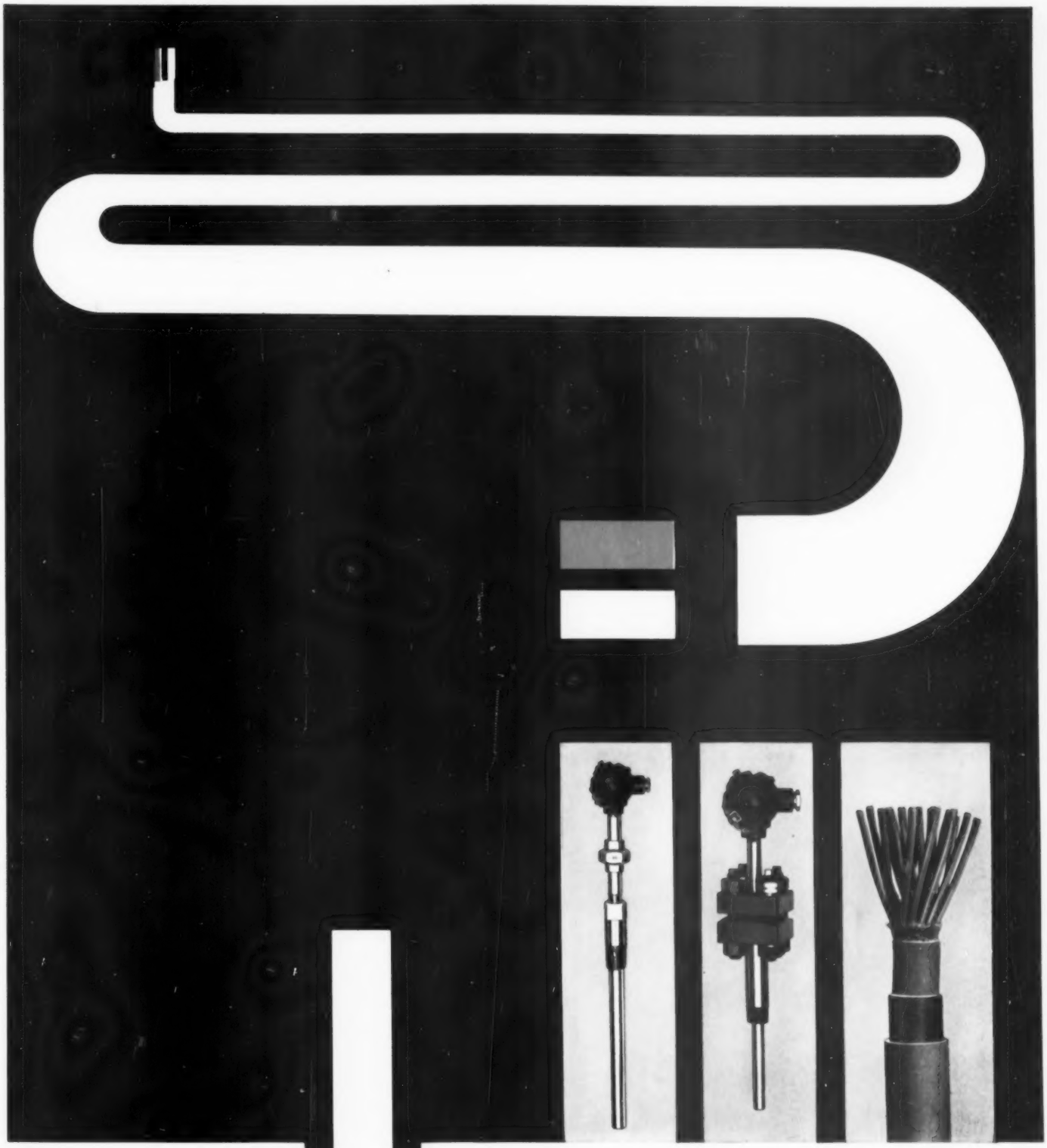
Measuring technique for non electrical units.
Measuring technique for electrical units.

In designing instruments for use in the petroleum and petrochemical industries particular attention is to be paid to the fact that they should be explosion proof. This, however, should not lead to a lesser legibility and facility of inspection. Since all petroleum and petrochemical processes take place in opaque pipes and equipment it is absolutely essential for the control of the operation that the measurable values of production and material conversion are visually shown by means of reliable precision instruments of greatest accuracy.

(Continued on page 154)

Central instrument board





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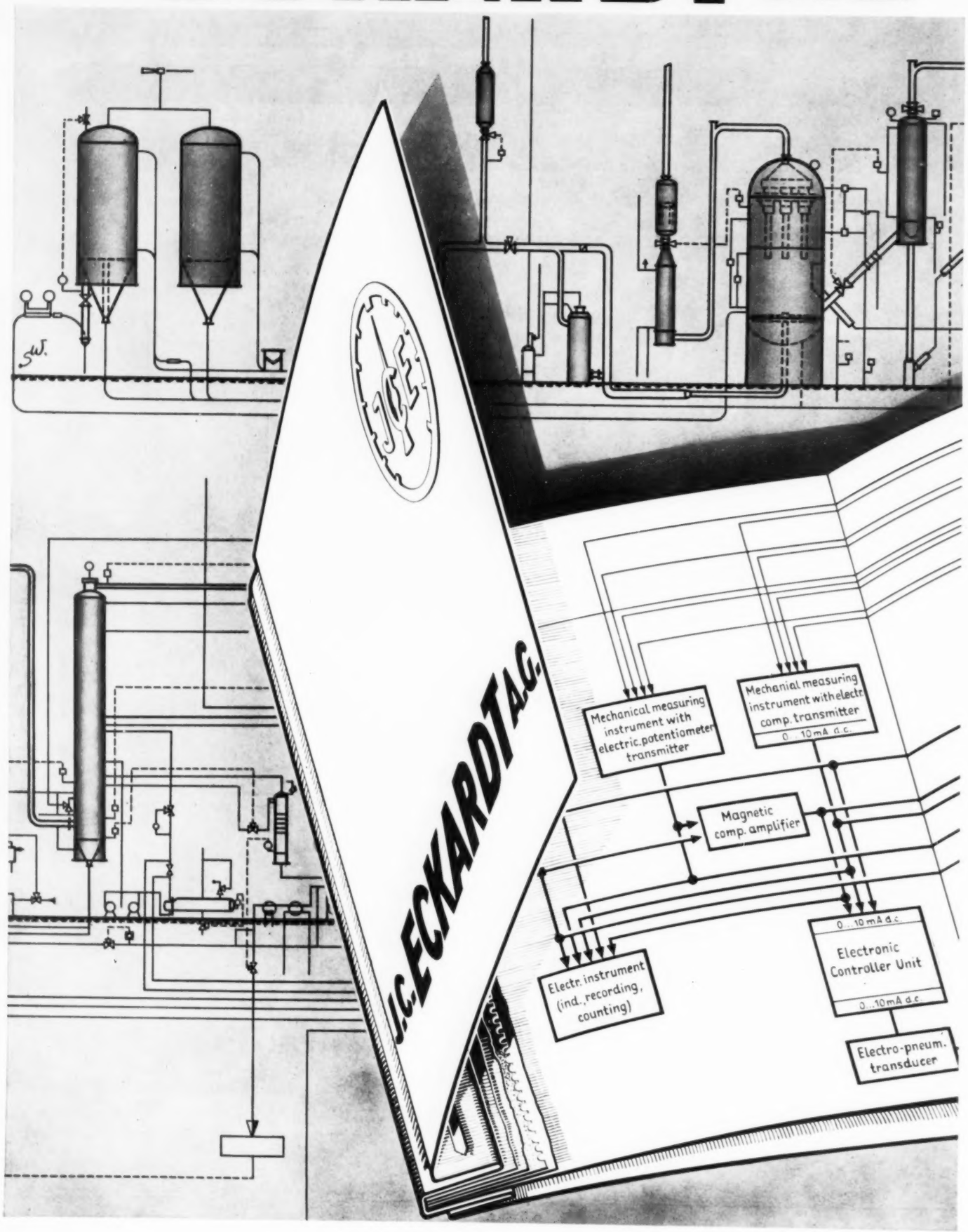

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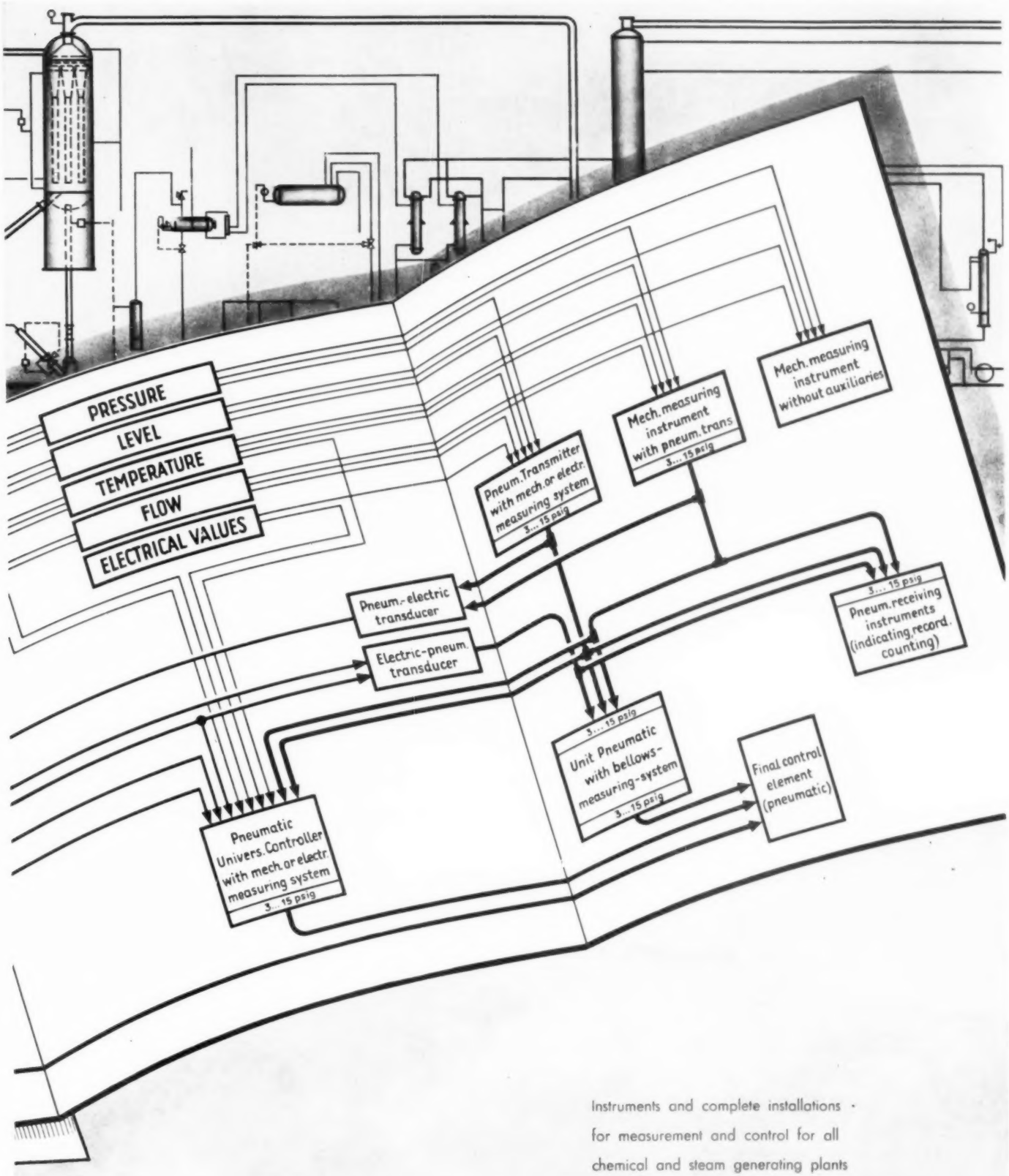
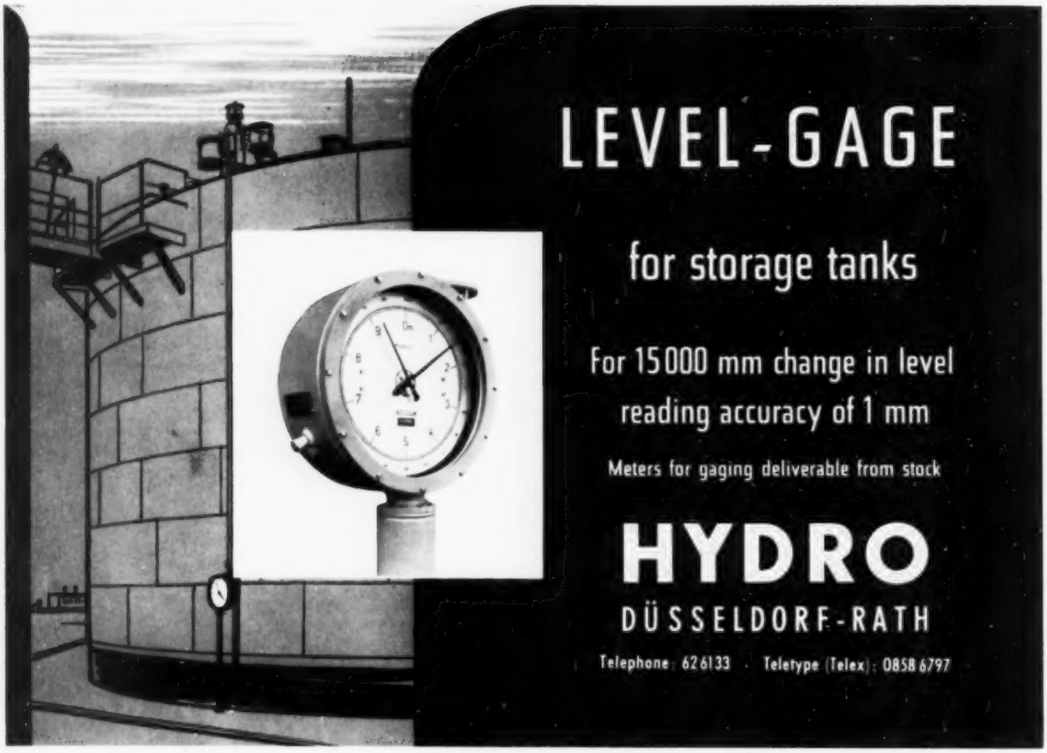


Instruments and complete installations · for measurement and control for all chemical and steam generating plants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(Continued from page 150)

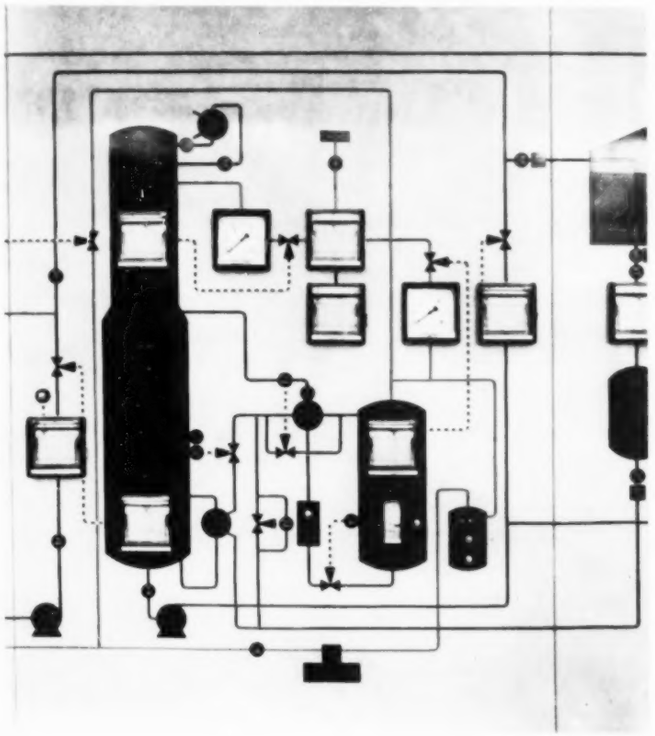
Noticeable changes in the application of measuring instruments with regard to the scope, the increased requirements of accuracy of measurement, and the potential of measuring possibilities were accompanied by demands of the refinery to alter measuring points from local indication to long-range transmission so that all operating and measuring values are shown at one central point, namely the instrument room. The latest developments reveal a further modernization of long range transmission by an increasing application of electronics.

The instrument manufacturer has strongly promoted the development of the impulse senders for long-range transmission (transmitters, transistors, magnetic amplifiers etc.) by increased use in new construction and research. The improvement of the long-range transmission of measuring values by means of pneumatic and electric transmitters enabled practically all instrument manufacturers to construct multiple purpose instruments. Also the development in Germany shows that the instrument manufacturers offer and deliver more and more complete measuring installations made up of prefabricated parts manufactured in economical mass production. Only in very few special cases individual types are offered and manufactured. These developments on the part of the manufacturer and the requirements of the production plants created the possibility of a centralized operating control without which we can hardly visualize the supervision of a modern crude oil processing and petrochemical plant.

The petroleum processing methods and the modern processes for the molecular hydrocarbon conversion in refineries, petrochemical and plastic industries require steady operating conditions and should be protected against internal and external disturbing influences. Therefore, a control of the operating conditions done by means of measuring instruments does not suffice but also requires an operater which in case of trouble immediately corrects it at the right place and in the right way. It is only a small step from precision measurement technique to control technique which in turn leads more and more to automatic operating control. The systematic development of precision instruments for the measuring technique, control technique and automatic control often created for the first time the possibility of carrying out processes and material conversions which man alone could not perform in a reliable and successful way.

An economic operation both with regard to uniformity of quantity and quality of the products is only possible in continuous operation with automatic control of all manipulations as far as products and utilities are concerned. Each control measure requires the exact determination and transmission of the measuring values. As a conse-

Installation of measuring and control instruments in flow diagram. Photo courtesy J. C. Eckardt AG, Stuttgart-Bad Cannstatt



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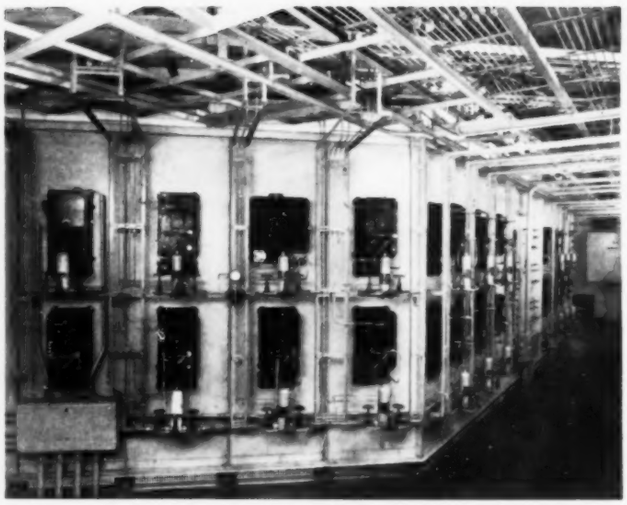
quence measuring and control technique became in modern industrial plants one inseparable system.

In the instrument room the transmitted measuring values give the impulses for the control devices of the regulating members of the controllers. Automatic control can only then become significant where it is used simultaneously for the overall supervision and control of the operation of a complete plant or of a plant part. The development of the measuring and control technique necessarily results in automatically functioning plants or installations. Especially the operation of refineries and petrochemical plants which require mass production of uniform quality necessarily call for full automatic control whereby the planning and construction engineer is charged with the creative task and as far as the operation is concerned with the responsibility to recognize and to eliminate troubles.

The same considerations and observations mentioned for the measuring technique hold good for the development of the instrument room. Pneumatic and electric instruments are used for control as well as for measurement. In most of the German systems for long-range transmission a combination of pneumatic and electric transmission is possible and is even recommended in case large distances have to be covered. As far as the pneumatic controller is concerned a standardization of the operating pressure range from 0.2 to 1 atm.g. is largely adopted whereas as far as the range of the electric current is concerned this lies between 0 and 200 mA.

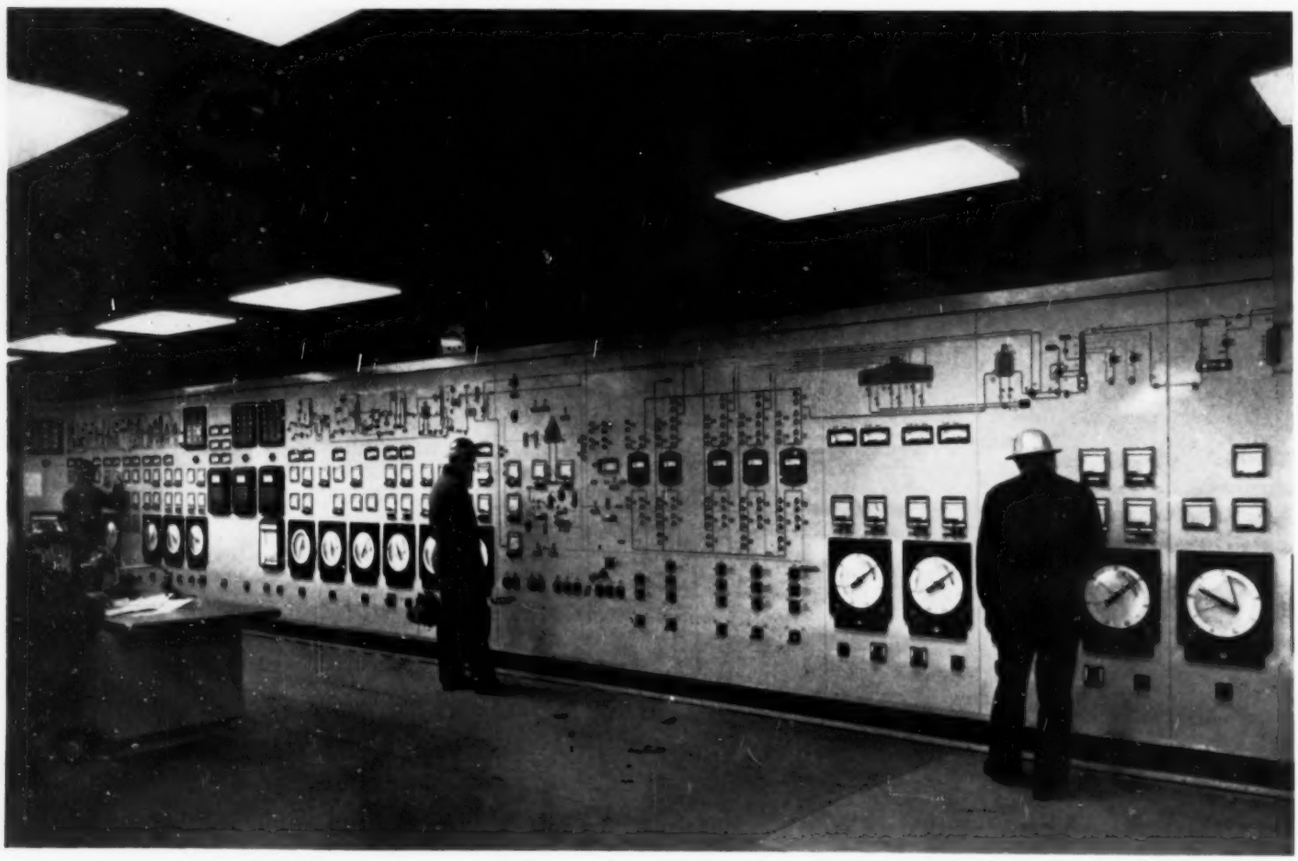
By means of special converters the results of measurement of the pneumatic and electric transmission may be converted in numeral impulses, which can be directly utilized in the control installation but also be relayed in the form of numerals to bookkeeping machines, hollerith systems and electric calculating machines.

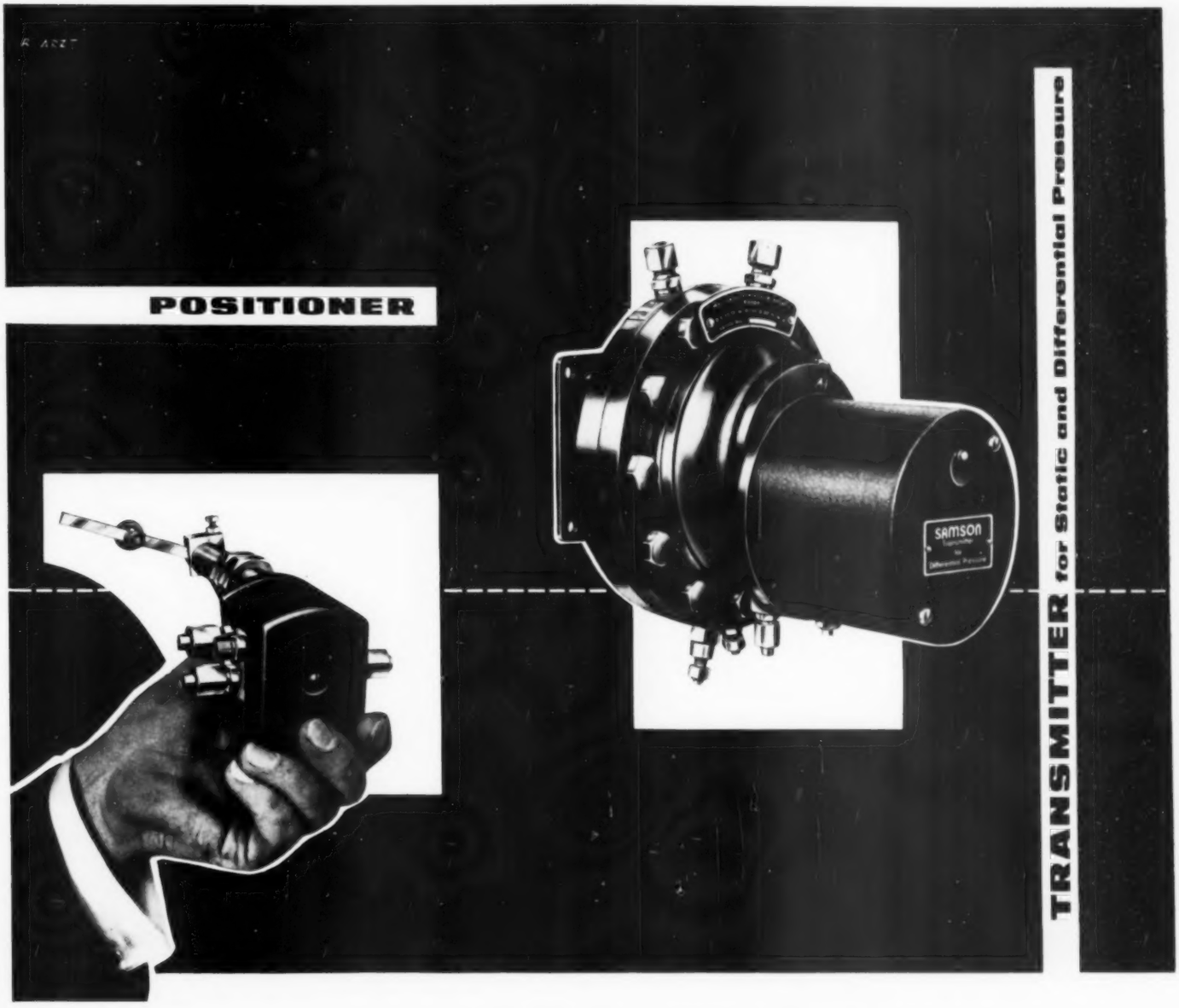
The numerous measuring and control instruments which have to be housed in one building lead to the installation of instrument boards of steadily increasing dimensions. In order to retain facility of inspection a flow diagram on which all measuring and control points are indicated is depicted on the instrument board. The use of coordinating signal lights or mounting of the indicating and recording instruments direct in the flow diagram guarantees facility of inspection. This latter in turn requires the use of the smallest possible size of the instruments to be included in the flow diagram. Nowadays a complete control instrument with recorder and controller with set-point and actual reading indication and all operating knobs occupies less space on the instrument board than the simplest recorder occupied about 30 years ago. With regard to the mounting of measuring and control instruments in the plant and on the board the photos included in the text give an idea of how at present the measuring and control system is centralized in a modern refinery.



Back view of an instrument board. Photo courtesy J. C. Eckardt AG, Stuttgart-Bad Cannstatt

Refinery instrument room. Photo courtesy Friedrich Uhde GmbH, Dortmund





For more than 50 years the SAMSON Apparatebau AG manufactures industrial heat controllers. Perfected constructions were obtained on the basis of experiences extending over a large number of years and have proven to be dependable and reasonable in price. The pneumatic controllers and remote control devices were developed on the basis of a prefabricated part system, so that each article can be used as such for a certain purpose, but also as prefabricated part for assembly into more elaborate installations.

SAMSON

In these modern shops the controllers and remote control regulators are fabricated and tested.

SAMSON APPARATEBAU AKTIENGESELLSCHAFT
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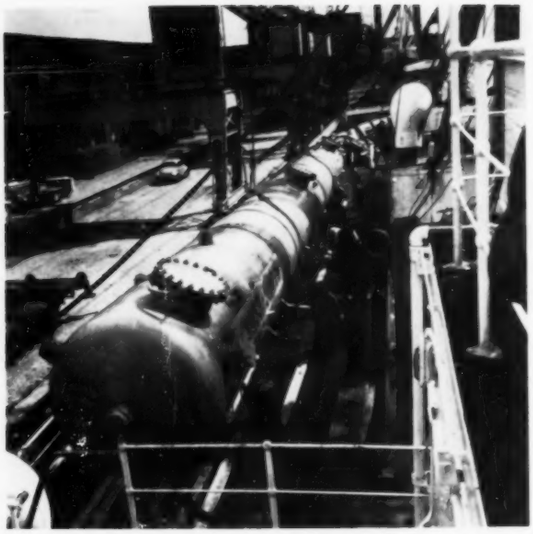
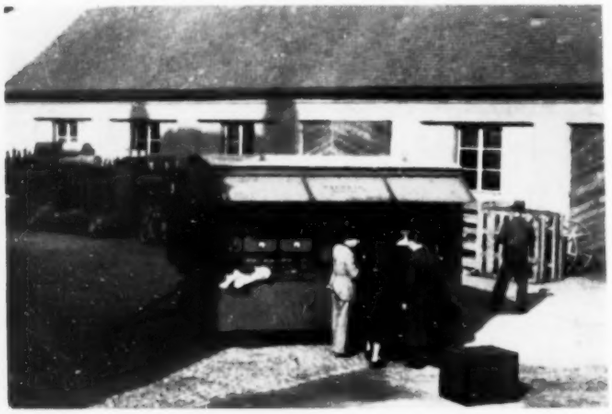
6

Process vessels equipment and tanks



Fractionating tower, diameter 6 m, 6 in., length 100 ft, on board steamer. Photo courtesy Müller Schuss KG, Siegen

IMPORTANT plant parts in which petroleum processes are carried out are manufactured in boiler and equipment shops. In these shops vessels and equipment for various purposes and in many different shapes and sizes are fabricated. Thick and thin plates are rolled, rings are welded and provided with heads, flanges, manholes and supports until finally the apparatus in its ultimate form is completed. The manufacturing program of these shops ranges from fabrication of plain, small thin-walled vessels to that of robot-like



Portable drying installation for specialty oils
Photo courtesy A. Hering AG, Nürnberg

reactors or thick-walled pressure vessels suitable for high temperatures and the most severe operating conditions.

The same careful attention is required for the handling of sheets of a wall thickness of only a few millimeters as for vessels made of sheets of a wall thickness of 50 (2"), 80 (3") and more millimeters.

As far as the quality of the work is concerned it does not make any difference whether such vessels will be operated under an extreme low vacuum or under a very high pressure. These conditions must of course be duly considered in the calculation and the construction of such vessels.

Before discussing the manufacture of those vessels and equipment a short review of the various shapes and types of such equipment will be given in which review the sequence does not at the same time indicate a classification with regard to quality or frequency of such parts.

Vessels are required in all branches of industry and all process stages. Plain vessels are used for the storage of liquids, motor fuels, lubricants, fuel oils, chemicals and process auxiliaries. A large number of this type of vessels is found in each refinery in which they are required as feed tanks, as preparation tanks, as storage tanks for products and auxiliaries and as storage tanks for intermediate products. These tanks are provided with nozzles for inlet and outlet connections, for measuring and controlling the product flow, with heating or cooling coils as far as the process these requires and with nozzles for safety devices and with ladders, stairs, platforms etc. These tanks are made in all different sizes and dimensions for atmospheric pressure, elevated pressure and vacuum.

Transportation conditions between manufacturer and customer are often decisive for the maximum size of the equipment to be manufactured. When using customary railroad cars the limiting dimensions of tanks are about a diameter of 3300 mm (11 ft) and a length of between 30 m (100 ft) and 40 m (130 ft). In special cases larger dimensions are possible when flat-bed cars and special trains under specified conditions are used.

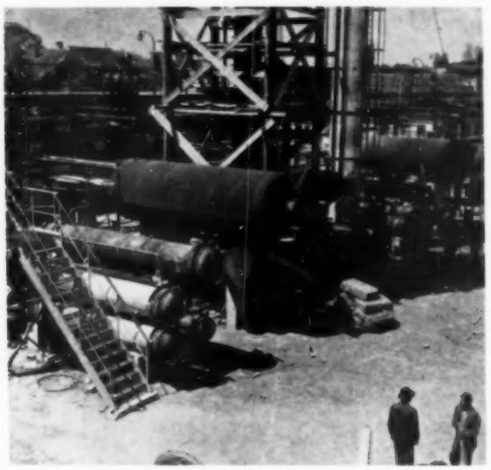
Road transportation of such large size vessels is permissible when using flat-bed trailers and then only under special police supervision. If water transportation is possible, larger size vessels can be shipped either on ships or freight barges or can be simply floated. In any case the transportation possibilities should be given due consideration during the designing. These vessels are known under very different names: LPG tanks, compressed gas and compressed air tanks; vessels for scrubbing, absorption or separation, disintegrators, absorbers, separators for liquids, such as gasoline, oil, water and sludge, catalyst and other residues of process auxiliaries. They further appear as towers for distillation and fractionation of petroleum, for stabilization and for re-running of motor fuels and lubricants and all different oil fractions.

Towers practically always contain complicated internal parts for supporting bubble cap trays, screening trays, hurdle-type trays or distributing trays in case packing material is used. The height of towers often amounts to 40 to 50 m (130 to 160 ft) and even may be as high as 70 to 80 m (220 to 260 ft) in case of precision fractionation

Fractionating tower, diameter about 11' ft, 8 ft., length 110 ft., being loaded on railroad cars. Photo courtesy Rheinstahl Union Brückenbau AG, Werk Orange, Gelsenkirchen

and are provided with many nozzles for product inlet and outlet, for connection to reboilers and pumps and provided with platforms and ladders for inspection and maintenance. With all these platforms, stairs and ladders, towers always make a fascinating impression.

Heat exchangers being installed. Photo courtesy Friedrich Uhde GmbH, Dortmund



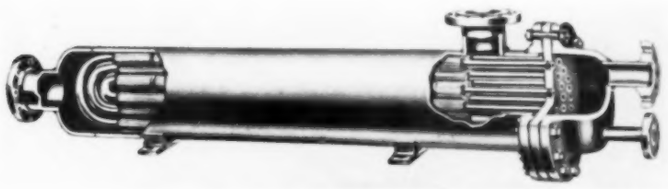
Other vessels have quite a different appearance, namely autoclaves, agitators and mixers which are required for processing, for the preparation of mixtures, dispersions or emulsions. Other types are used to avoid the formation of undesirable emulsions in which case the agitators are constructed as demulsifiers. Large tanks are required for the drying of test gasolines and transformer oils as well as for that of hygroscopic gases. These driers guarantee the attainment of the desired final condition of products, either by means of mechanical internals, by means of heat or by the use of physical or chemical drying means which promote the separation of liquid.

Different types of filter are used for the clarification and separation of solids. These filters can be applied as plain screens, as band filter and filter press, as rotary filter, as hydrocyclone and cyclone and as filter for the removal of the finest dust particles.

In the catalytic processes dust removal from recycle and tail gate is particularly important. Dust removal and drying of compressed air is a very important requirement in case this air is used for measuring and control instruments. The compressed air system must function smoothly and without pressure variations. This is attained by the installation of tanks which, if properly dimensioned, act as buffers.

Heat exchangers constitute an extensive special field of equipment manufacture. This group includes coolers for gas, vapor and liquid, condensers for the total or partial liquefaction of gas and vapors, heat exchangers between incoming and outgoing products, evaporators and superheaters.

These heat exchangers can be designed for parallel flow, counterflow or for a combination parallel-counterflow depending on the

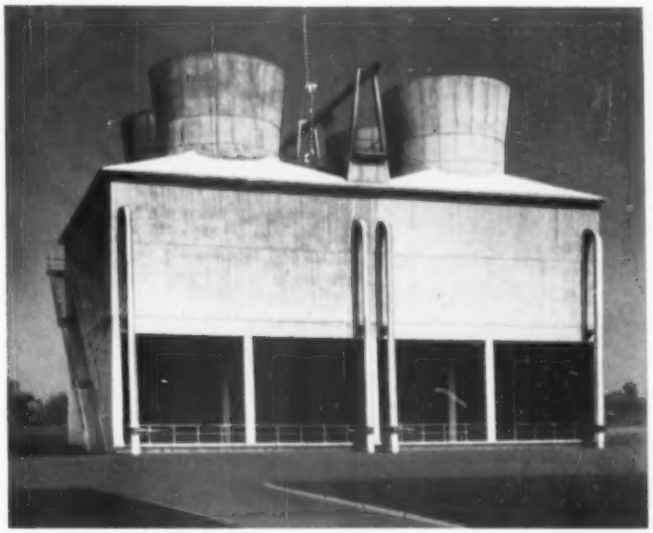


Brown Flintube heat exchanger. Photo courtesy Friedrich Uhde GmbH, Dortmund

operating conditions and the process auxiliaries. Although the indirect exchange constitutes the most commonly used method in many processes the direct exchange with cooling or heating medium is done by means of spraying, dipping or scrubbing. A vessel which can be heated or cooled represents the simplest form of transfer. For this purpose jackets, ribs, welded-on pipes and pipe coils, and built-in tube bundles are used. A disadvantage of these is that op-

(Continued on page 168)

BISCHOFF DESIGNS AND BUILDS



WATER RECOOLING PLANTS
of any design for all requirements

- **Counterflow Coolers**
- **Induced and forced draft Fan Coolers**
- **CO_2-Discharge Towers**

furthermore:

Gas Processing Plants

for Town Gas, Blast Furnace Gas, Synthesis Gas, Exhaust Air for

- Desulphurization
- Dust Separation
- Detarring
- Cooling and Drying

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Telephone No.: 20591

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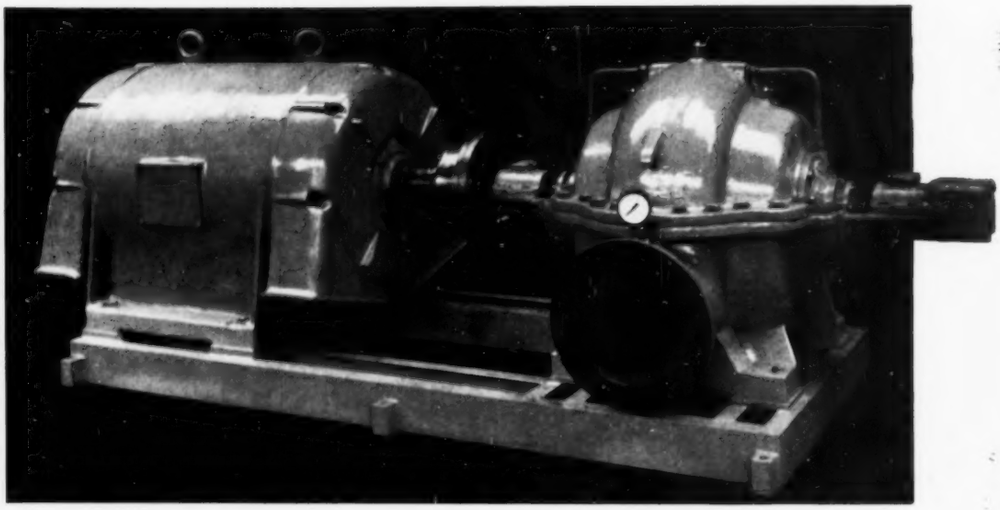
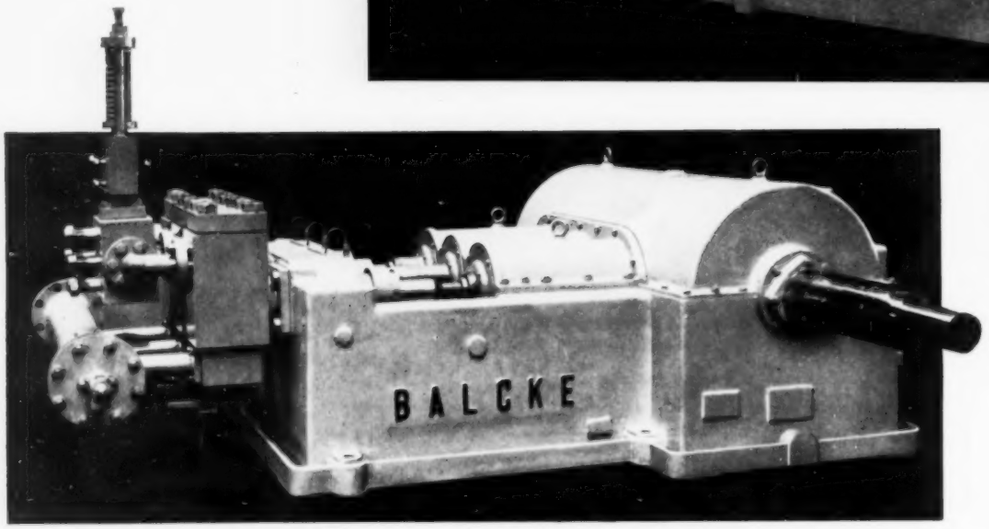
Where There's Refining

Fuel Oil Pump TW 250a for 1320 US gpm fuel oil; head 67.5 psi, 1450 rpm. Horizontally split pump casing with suction- and delivery branch at the lower part of the casing, easy pump maintenance after removal of the casing cover without dismantling the piping. Pump in special design with special slip-ring packing.



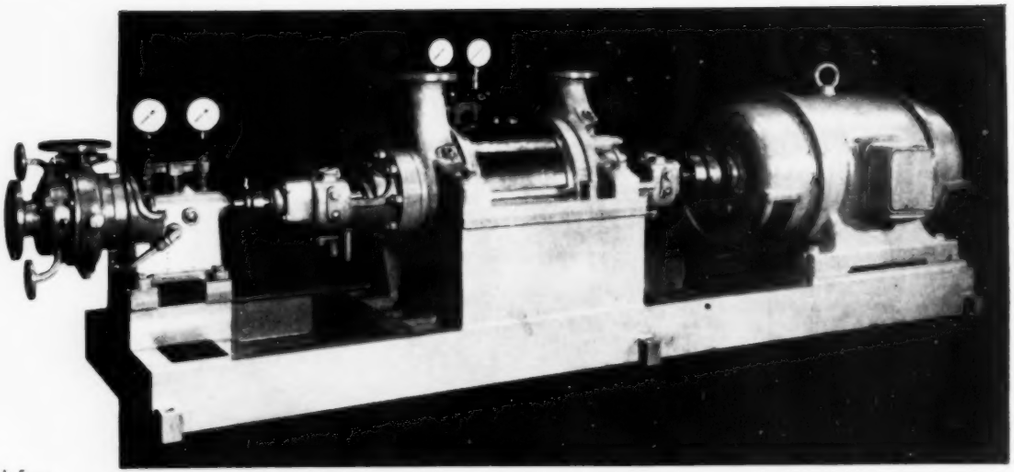


3-Plunger Pressure Pump LPP for crude oil 396 US-gpm at 1420 psi, resp. lower quantities at higher pressures.

Fuel Oil Double Pumping Set of special material for 66,000 lbs/hr fuel oil; water cooled stuffing box and bearing, 2,900 rpm, consisting of:

a) pump S 65 s, head 42.5 psi, heated suction cover,

b) main pump TSMH 3V, head 370 psi, maximum pressure 425 psi, casing supported at the head of the pump shaft, steam jacket over the whole shaft.



For **Steam Power Stations** and for the **Oil, Coal and Chemical Industries** we have been designing and building since 1894 up-to-date Pumps of all kinds for the transport of oil; Pumps for viscous liquids, Pressure Pumps, Hot oil pumps, Piston & Rotary Compressors, Dry Running Compressors, Fire Engines, Vacuum Pumps.

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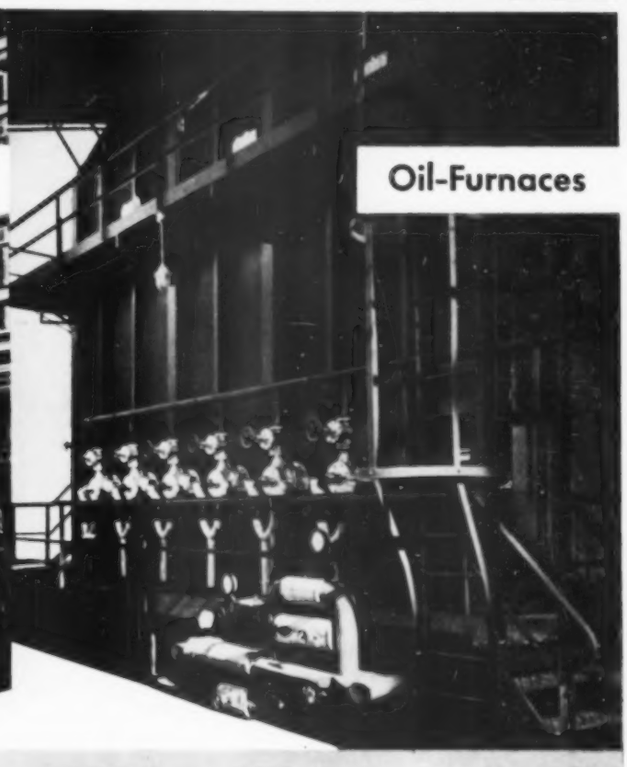
There Are Products Of BALCKE

Exchangers



Oil-Furnaces

Cooling Towers

For **Steam Power Stations** and for the **Oil, Coal and Chemical Industries** we have been designing and building since 1894 up-to-date Feed and Cooling Water Circulation Plants of any system; Cooling Towers; Heat Exchangers; Heaters; Evaporators; Steam Converters; Steam Jet Air Pumps and Compressors; Oil, Air and Gas Coolers; Gas and Oil Burners. Constructors of special plants to own or specified designs up to the largest dimensions.

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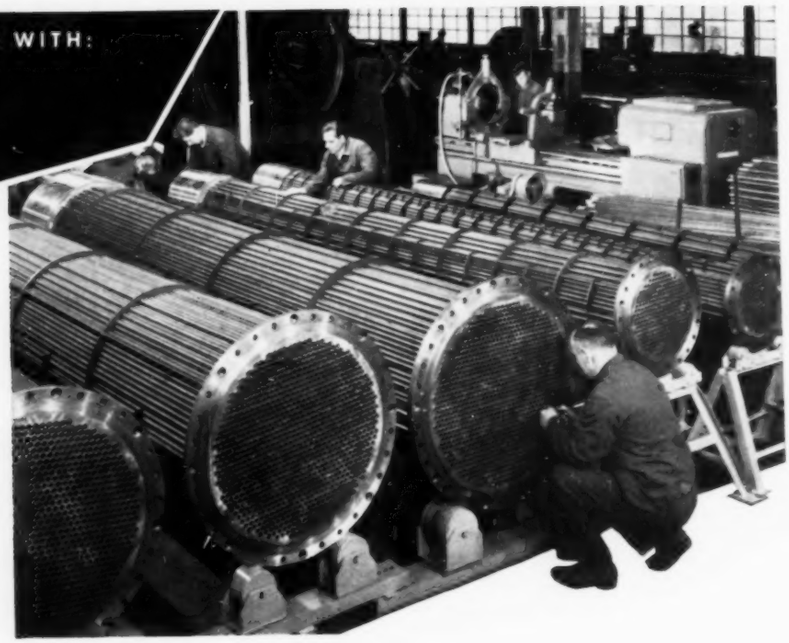
WE SUPPLY THE PETROLEUM INDUSTRIE WITH:

Distillation and fractionation columns
Cracking towers Polymerisation towers
Tar separators Heat exchangers
Pipe lines

As construction materials are used:

Corrosionproof steels, non-ferrous metals, plated materials, Hastelloy, Titan and Tantal



Tube bundles for floating head head exchangers, tube sheets and floating heads of copper silicon bronze, rolled tubes of pure copper.

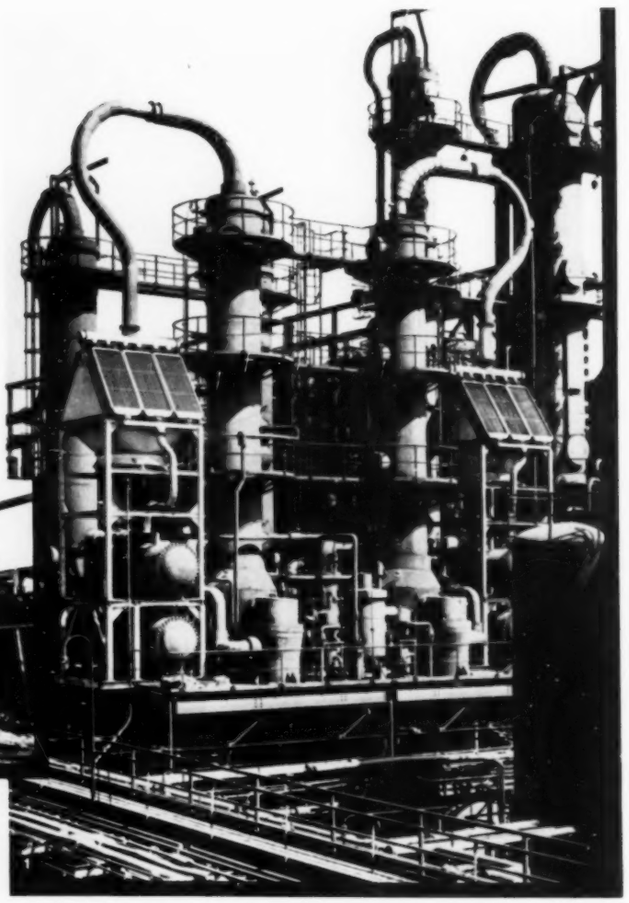
CANZLER

CARL CANZLER · DUEREN · GERMANY

AIR

INSTEAD OF WATER

When using air as cooling agent petroleum refineries are less dependent on cooling water and on the choise of site. Air cooled heat exchangers are more reliable and more economic than water cooled units.
Since more than 20 years GEA constructs air cooled units for power stations, for the chemical and petroleum industries, particularly in the space saving roof-type construction. Air cooled units are designed and constructed in accordance with ADN- and TEMA-Standards, and the ASME-API-Code.



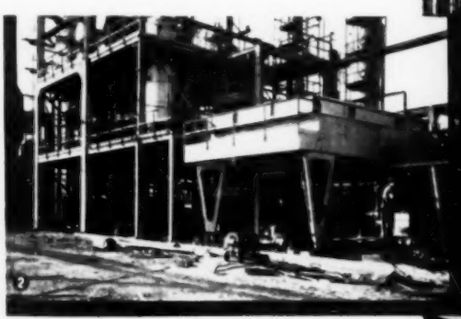
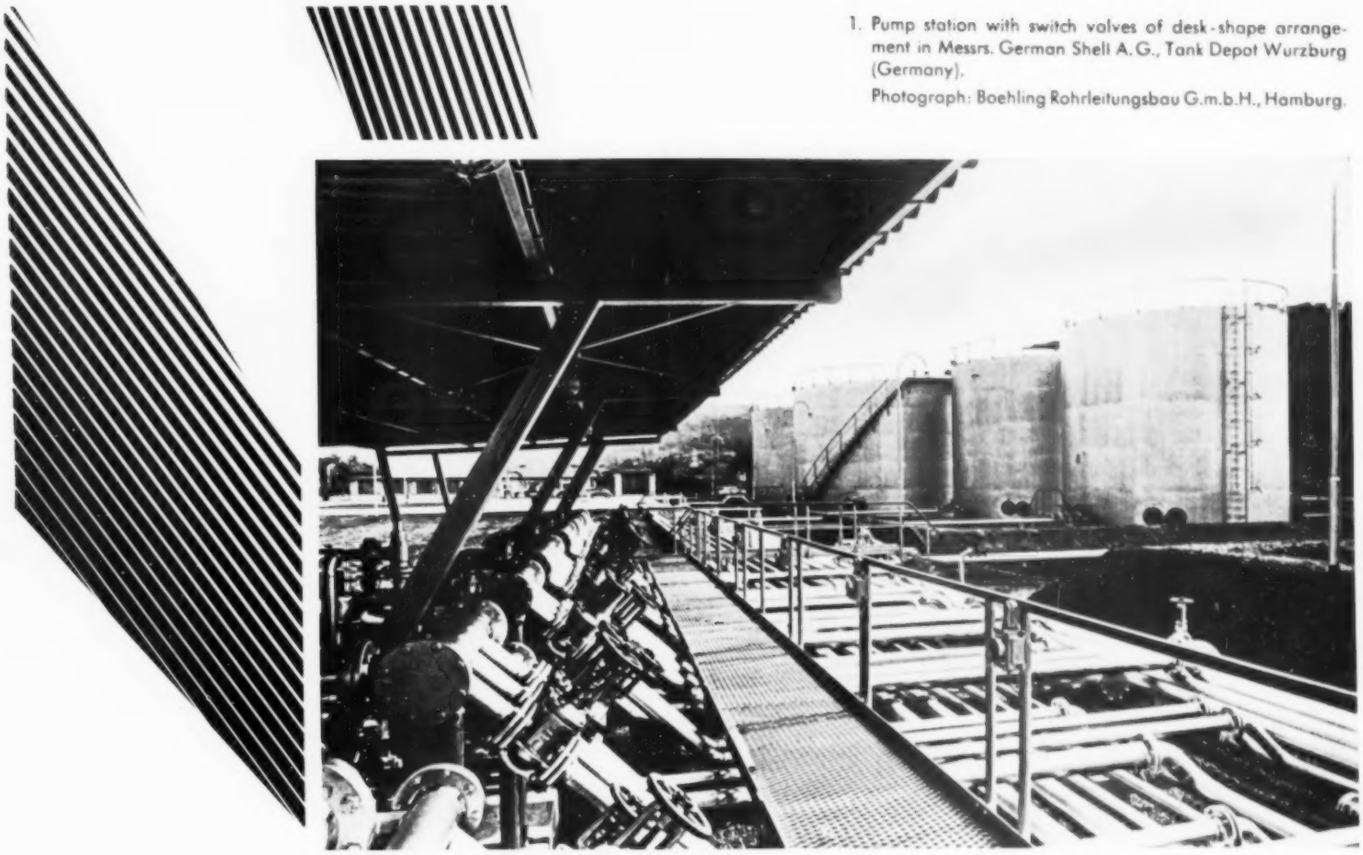


Fig. 1 Air cooled condensers for hydrocarbons, roof-type construction
Capacity: 10×10^6 BTU/h

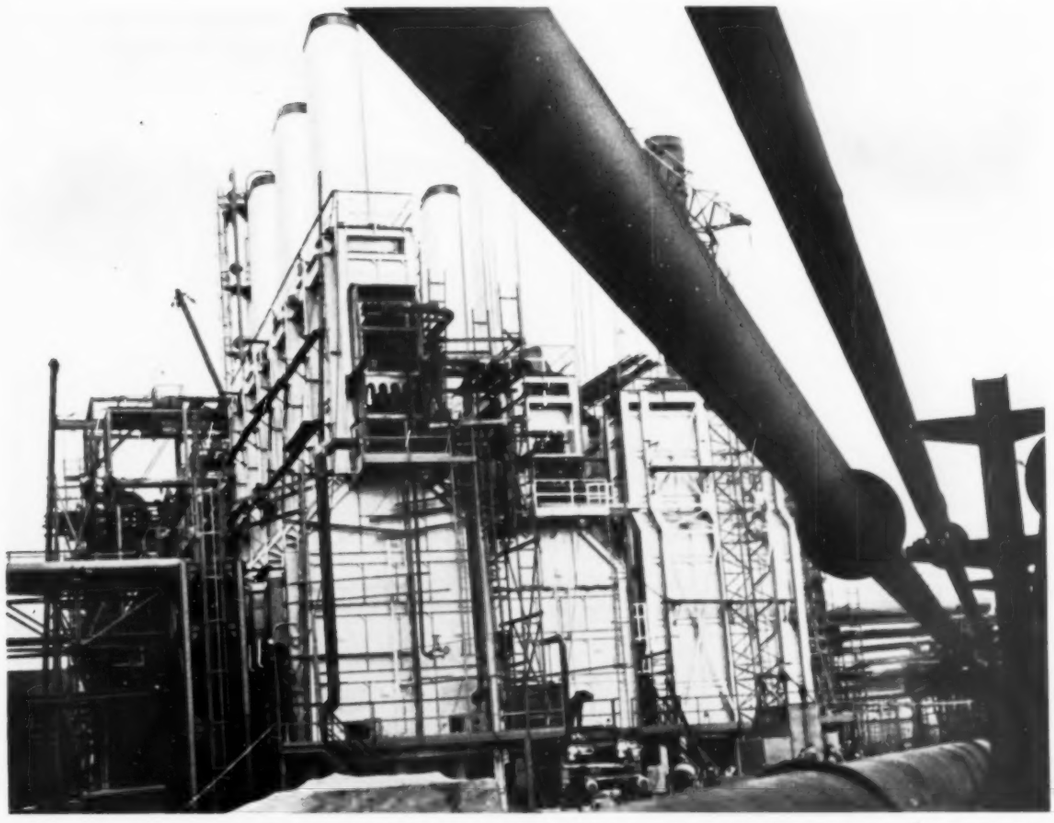
Fig. 2 Air cooled liquid cooler for crude oil,
Capacity: 18.6×10^6 BTU/h

GEA

GEA-LUFTKÜHLERGESELLSCHAFT MBH
BOCHUM WESTERN GERMANY



1. Pump station with switch valves of desk-shape arrangement in Messrs. German Shell A.G., Tank Depot Wurzburg (Germany).
Photograph: Boehling Rohrleitungsbau G.m.b.H., Hamburg.



2. Furnace group of a platforming plant with Messrs. Gelsenberg-Benzin A.G., Gelsenkirchen (Germany).
The construction includes heating systems of 120 t alloy steel piping and 60 t carbon steel piping to ASA standards.
Photograph: Boehling Rohrleitungsbau G.m.b.H., Hamburg.

BÖHLING ROHRLEITUNGSBAU GMBH Hamburg 27

See or Phone Mr. Böhling at the Plaza Hotel, 5th Avenue, 59th Street
New York, N.Y., from May 27th to June 6th, 1959, or at the Exhibition Location Nr. 570

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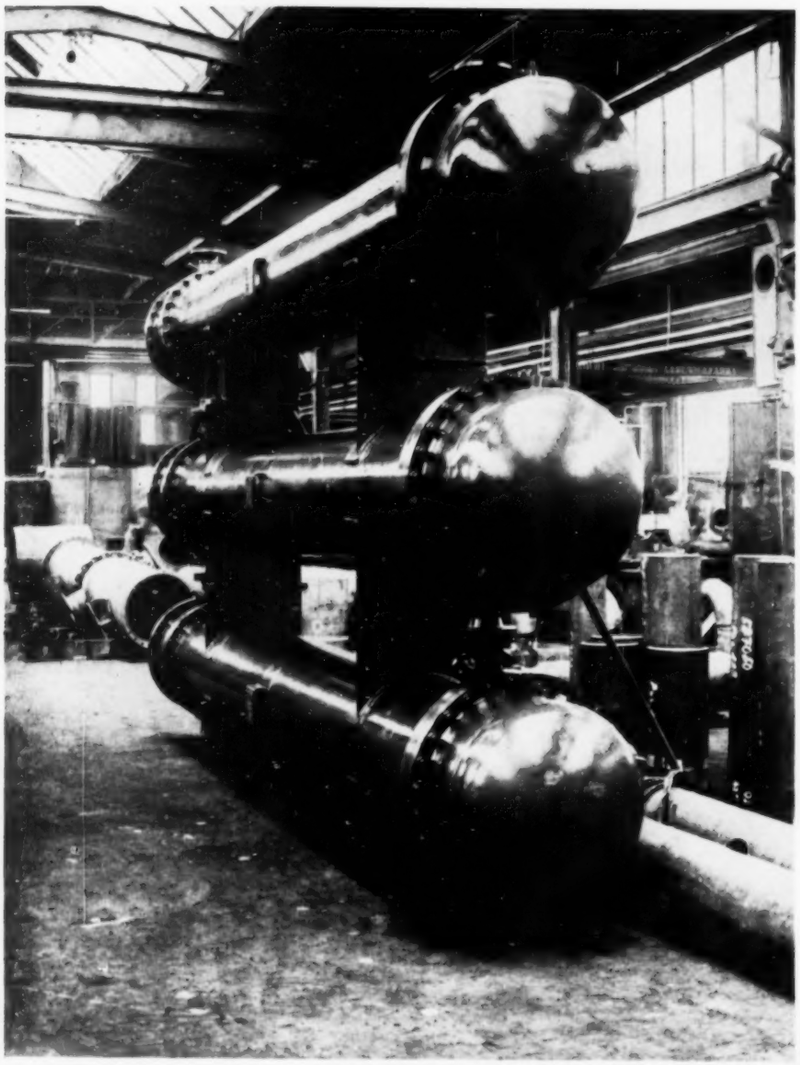
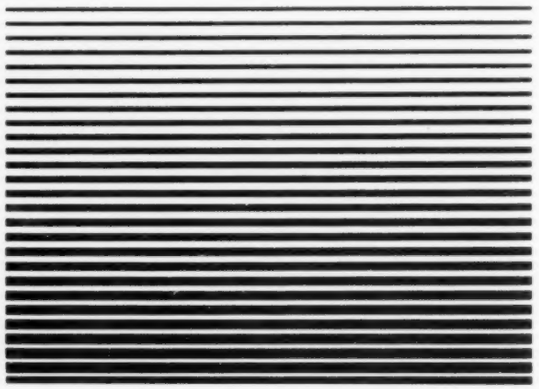
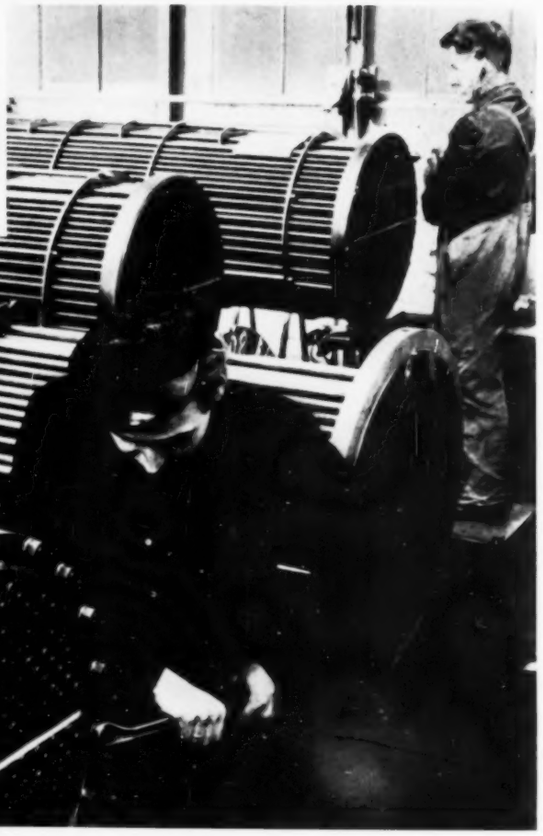
Gebr. Böhling · Apparatebau · Hamburg 27



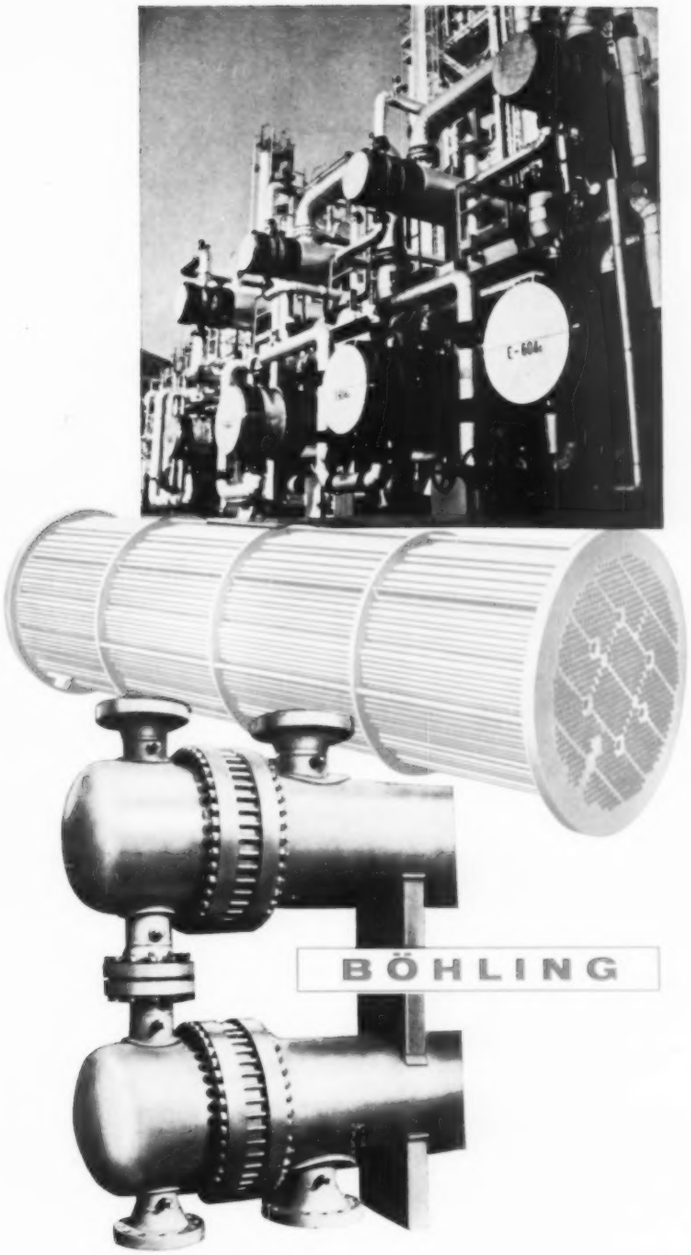
3. Heat exchanger group for a large refining plant.
Photo: Gebr. Boehling, Hamburg.





4. Heat exchanger tube bundle
at the assembly bench.
Photo: Gebr. Boehling, Hamburg.

See or Phone Mr. Böhling at the Plaza Hotel, 5th Avenue, 59th Street, New York, N.Y. from May 27th to June 6th, 1959 or at the Exhibition Location Nr. 570



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BÖHLING a name
which 50 years ago for the first time became well known by the invention of the hot-worked tube turn which has been manufactured according to our patents and used in the United States for more than 30 years

BÖHLING a conception
since centuries for special efficiency in the field of equipments and pipe lines for the chemical, oil and food industry

BÖHLING heat exchangers for all working conditions, tank heaters for the oil industry

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117 Großmannstraße, Hamburg 27, Germany

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equipment for the petroleum industry

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Reactors, fractionating towers, reboilers, heat exchangers, chillers, pressure vessels, pipework.

With application to all normal, alloyed and plated steels for operation under pressure and vacuum, electrically hand and/or machine welded (Elira and Arcatom procedures), X-rayed, stress-relieved, with ultrasonic inspection or magnetic particle test.

To all German and foreign specifications and codes (e.g. ASME, TEMA, Lloyd's Register, etc.).

With joint efficiency 80, 90 and 100% or First Class Welding Certificate.

Field assembly and erection of apparatus and plants by highly skilled specialists.

Gas and Air Compressors

horizontal, vertical and angle type, for all pressures and capacities. Special compressors (non-lubricated) for petroleum refineries. Natural gas compressors. Portable compressor sets for oil field applications.

Industrial Refrigerating Plants

any kind, operating on all refrigerants. Piston and turbo compressors, condensers, evaporators and coolers. Low-temperature cooling equipment for liquids and gases. Low-temperature gas liquefying plants. Absorption refrigerating plants, single and multi-stage, e.g. for waste heat recovery. Refrigerating plants for water recooling and air conditioning.

Steam Power Plants

Co-ordinated planning, design and construction of complete plants. Superintending of all job site work. Consulting engineering on all problems of heat economy. Waste heat recovery, feedwater economy.

All major parts such as boilers, turbines, pipework, HP gate valves, preheaters and vessels manufactured in own shops.

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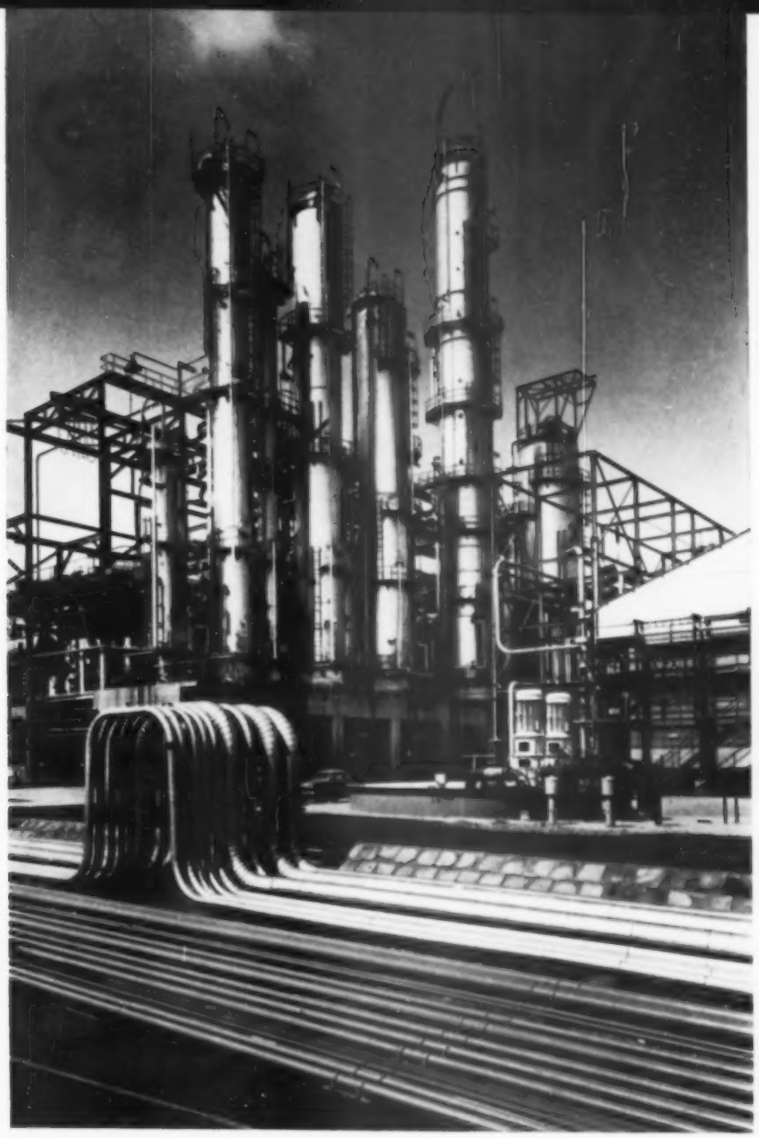
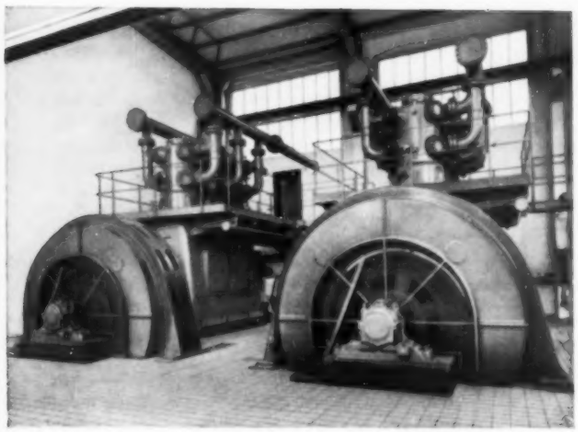
BORSIG

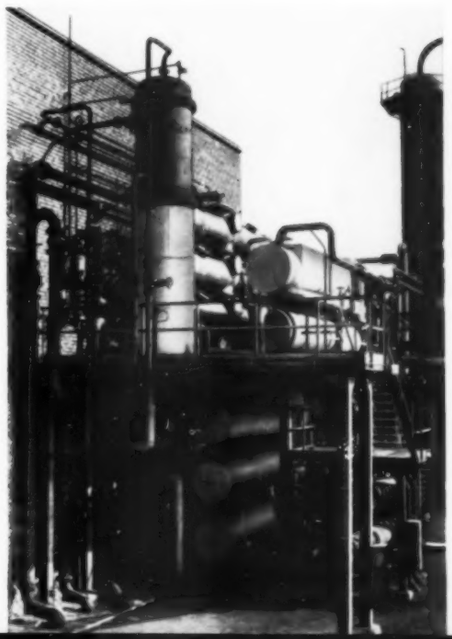


Fractionating columns, total weight incl. internals 985 tons, made and erected by BORSIG, Berlin, for a crude oil distilling plant; highest atmospheric tower 155 ft, outside dia 13 ft, weight 100 tons

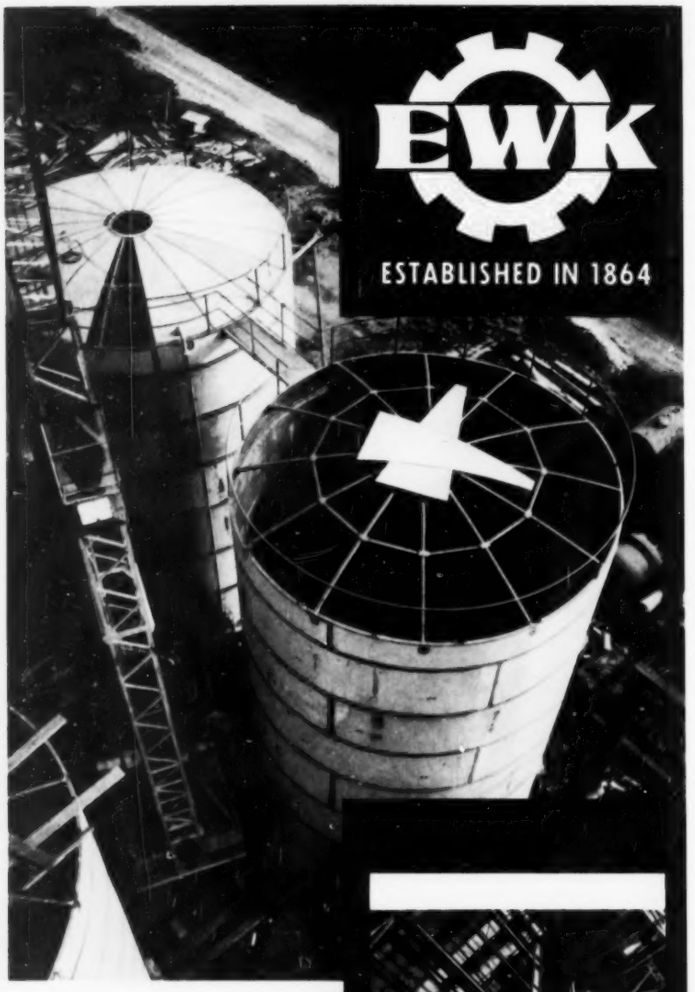


Non-lubricated recycle gas compressors of a refinery in Western Germany. Capacity 57,700 scfm each, suction pressure 440 psia, discharge pressure 725 psia, power consumption 2850 HP each

Power Station 60 MW



Total view of a BORSIG absorption refrigerating plant operating on waste heat of oil, for cooling liquid hydrocarbons. Capacity: 232 tons of refrigeration at 28/104° F



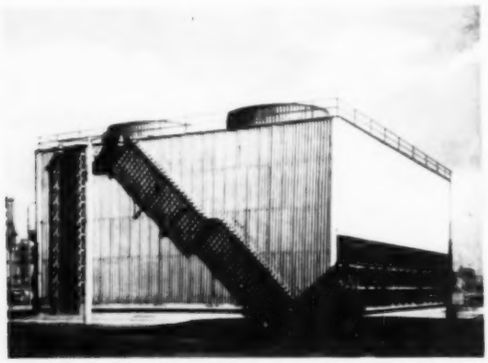
- Large size vessels
- Pipe lines
- Storage tanks
- Equipment construction
- Columns
- Gas compressors
- Steel structures

EISENWERKE
KAISERSLAUTERN
GERMANY

(Continued from page 159)

erating variations and desired changes in operating conditions cannot be easily taken care of since these systems due to the volumetric differences function too slowly on account of their limited exchange surfaces. They are mostly used for batch operation in which definite residence times exist. For exchange in processes in continuous operation tube bundle equipment, double and multiple pipe coils are mostly used. With these types of exchangers all operating conditions like temperature, temperature drop, volume, heat content, flow velocities and effective exchange surface are calculated during the design period. Furthermore, this apparatus can be adjusted on short notice with proper measuring and control instruments.

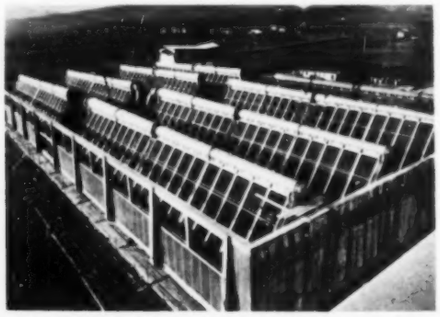
Evaporators represent a special type of exchangers. These must be very carefully designed in view of the large amount of heat usually required for the evaporation of the product. In the case of high capacity evaporators particular attention should be paid to the provision of adequate compensation for taking up the changes



Cooling Tower. Photo courtesy Ernst Kirchner, Hamburg 1

in length due to temperature differentials. The application of spiral tube bundles with spherical collectors results in exceptionally large exchange surfaces with adequate flexible compensation. The film evaporators which in practically all cases apply the film evaporation in their construction are supplied in many different forms. In this construction the exchange surfaces must be large and the exchange elements must be so shaped that in a very short time the temperature exchange between heat carrier and product can take place with a simultaneous transfer of large amounts of heat. For evaporators and heaters steam, combustion gas, hot air, hot water or heat-proof oils are mainly used as heat carrier for the exchange whereas water is mainly used as cooling medium in condensers and coolers. However, lately air as cooling medium is in many cases successfully applied. Brine and special refrigeration means are used for obtaining low temperatures. Although air is mainly used for high capacity coolers in cooling installations and cooling towers its use in small size condensers and coolers is nowadays also economic.

It gets steadily more difficult with increased industrialization to dispose of suitable cooling water in adequate amounts. Those plants equipped with a recycle water system with cooling water towers



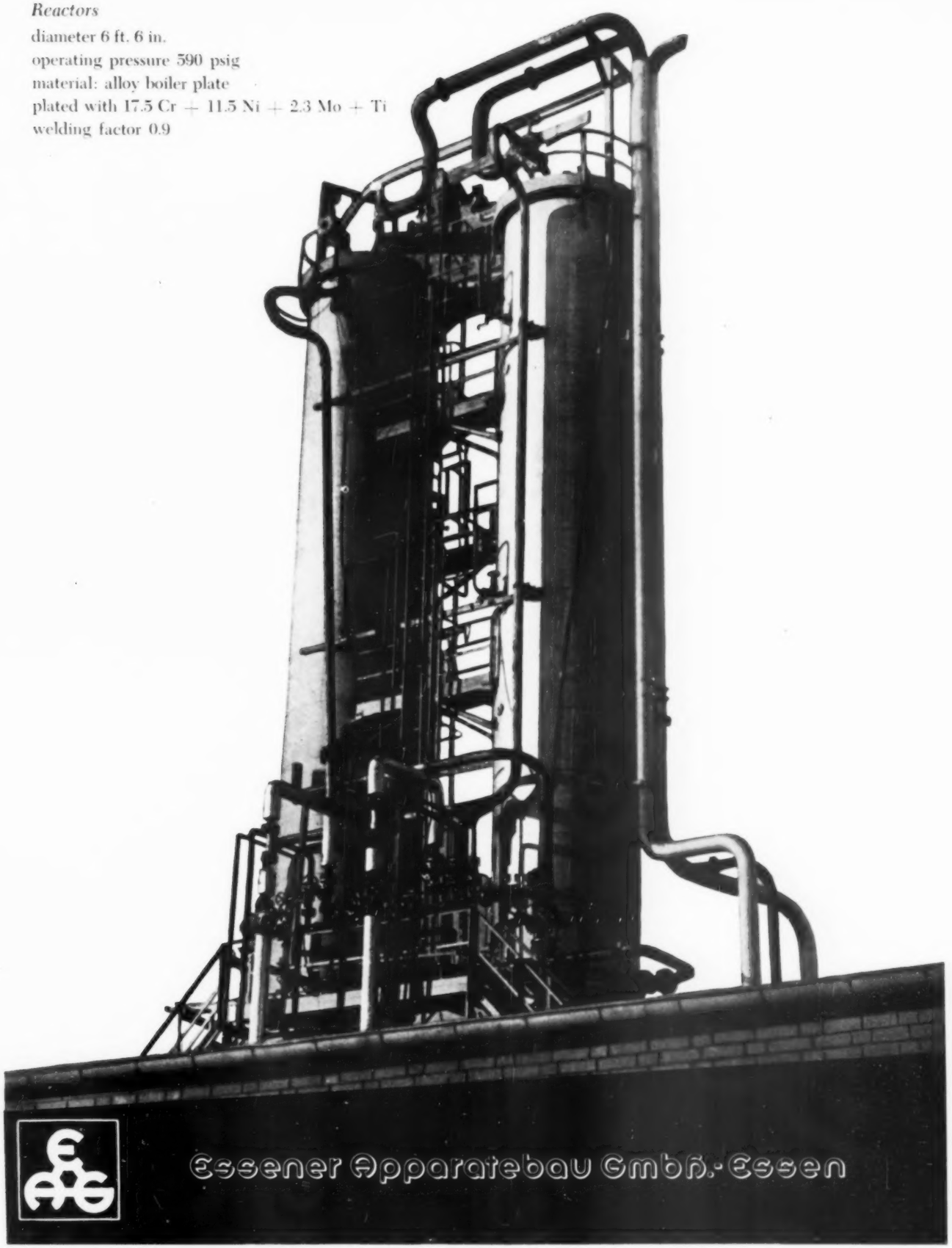
Air-cooled condensers for 140 tons/h of waste steam. Photo courtesy GEA Lüftkühlergesellschaft mbH, Bochum

suffer during summer such high evaporation losses that the make-up and the continuous purification of the recycle water brings about many problems for management. In industrial areas the agglomeration of various branches of industry causes an appreciable shortage of cooling water and the available water is highly contaminated and

(Continued on page 176)

Reactors

diameter 6 ft. 6 in.
operating pressure 590 psig
material: alloy boiler plate
plated with 17.5 Cr + 11.5 Ni + 2.3 Mo + Ti
welding factor 0.9



Construction and mounting of
BIG CONTAINERS, TANKS, etc.

Manufacture and supply of
electrically welded („Ellira" process)
STEEL TUBES and **PIPELINES**

KÖLSCH-FÖLZER-WERKE A.G. SIEGEN i.W. WEST GERMANY

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Processing and storage equipment for the petroleum industry

Aug. Klonne, Dortmund

Picture 2: Indirect heater.

MANUFACTURERS of refining and petrochemical processing equipment and storage vessels for liquids and gases.

Aug. Klonne fabricates high efficiency continuous atmospheric and vacuum distillation units, thermal and catalytic cracking and reforming plants, including all fractionating towers, heaters, exchangers and other auxiliary equipment.

Indirect heaters are built for either oil or gas processes; free water knockouts are designed to operate at pressures up to 350 atm. (5000 psi); natural gas dehydration units are erected, employing either dry desiccants or the glycol process; oil gas separators, well checkers and other oil field equipment is available on short notice. Engineering advice and assistance is offered for the solution of special programs and difficulties at refinery and oil field levels.

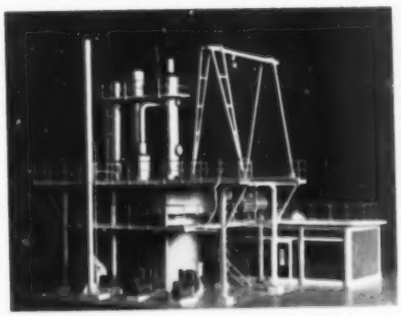
Heat exchangers, towers and condensers and other processing and treating equipment are built to any specification in our works for the oil refining and petrochemical industry.

Our efficient steel superstructure department builds steel frames, floors and platforms so that equipment of the heaviest type may be erected simultaneously with piping, connections and main structures.

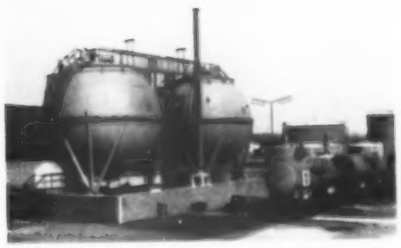
We design and manufacture automated cracking units for the continuous production of town gas or gas for manufacturing purposes from liquid and gaseous hydrocarbons. Continuous operation of this thermo-catalytic process is not interrupted for catalyst regeneration. Individual tubes may be replaced in the multi-chamber furnace without shutting down the operation.

Spherical pressure vessels have been improved by our tank and gas-holder department following the development of weldable types of high-tensile steel. We are thoroughly experienced in the fabrication of spherical or cylindrical pressure storage for industrial or town gas or liquefied petroleum gases. Design of all holders and tanks includes thoroughly tested supporting structures for field and plant installation.

Economical manufacturing procedures have enabled us to increase our volume of tank building business at a rapid rate. The tank department erects fixed and floating roof tanks. Floating-roof tanks have been erected with capacities up to 32,000 cubic meters employing our own efficient type of roof seal.



Picture 3: Model of cracking plant for LPGas or crude oil feed.



Picture 4: Spherical LPGas containers with capacity of 500 m3.

Picture 1: Emulsion treaters.

Picture 5: Floating roof tanks of 31,500 m3 net capacity.

Advertisement

Without Steel no Petroleum

KLÖCKNER-GEORGSMARIENWERKE AG OSNABRÜCK

Tanks with fixed – and floating roof · Wet seal gas holders · Spherical gas holders for high pressure storage of gases and liquid petroleum gases Pressure vessels · Towers for distilling and refining · Absorber towers · Reactors Evaporators · Heat exchangers · Condensers · Agitator vessels · Settling tanks

KLÖCKNER-HÜTTENWERK HASPE AG HAGEN-HASPE

Merchant bars and shapes · Heavy and medium plates

KLÖCKNER-HÜTTE BREMEN AG BREMEN

Heavy and medium plates

KLÖCKNER-MANNSTAEDT-WERKE GMBH TROISDORF

KMT sections, hot rolled, cold shaped · Grey-iron cast · Bolts and nuts

KLÖCKNER-DRAHTINDUSTRIE GMBH DÜSSELDORF

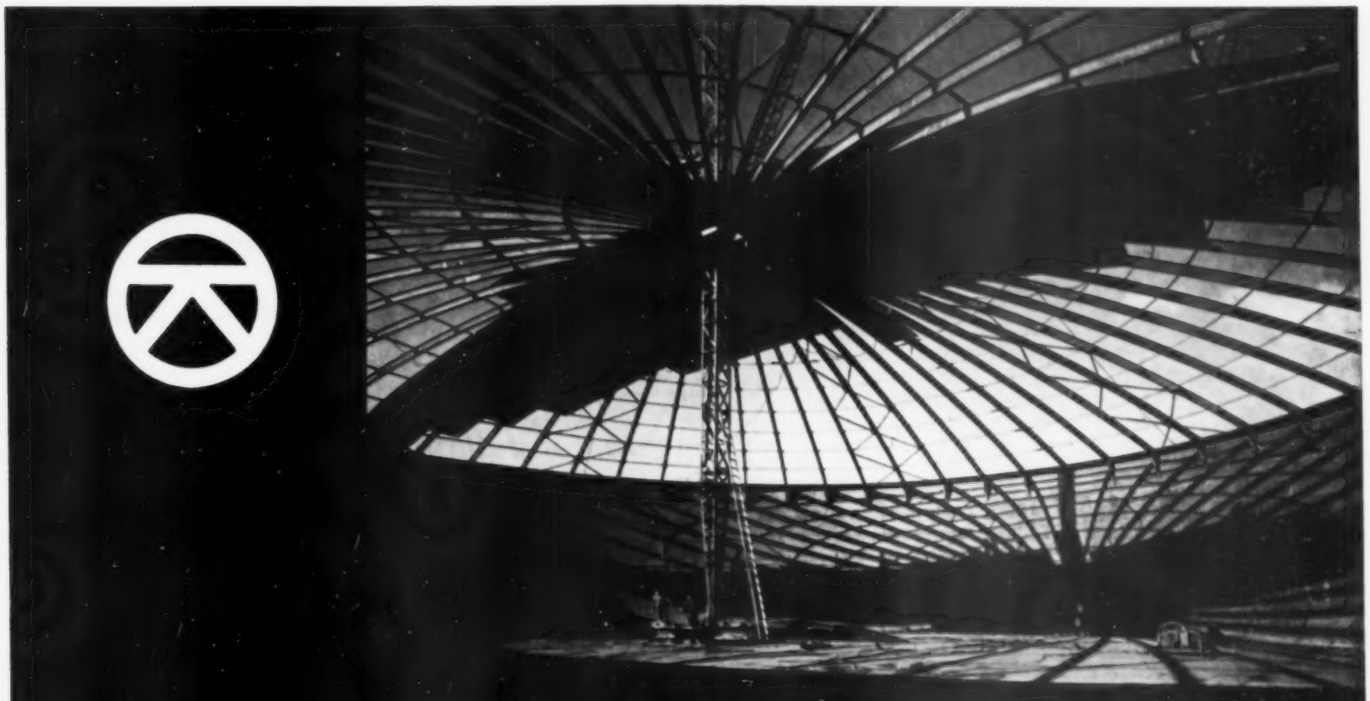
Oil field wire ropes · Welding electrodes

Every 15 seconds the Klöckner-Werke produce one ton of ingot steel. On hundreds of rolling stands and in numerous workshops – from the forge to the welding shop, from the wire rope plant to the electrode plant – we process this steel.

All the technical possibilities and experiences developed in producing and processing steel for more than a hundred years serve the petroleum industry also through our department of container and apparatus construction.

KLÖCKNER

KLÖCKNER-WERKE AG DUISBURG



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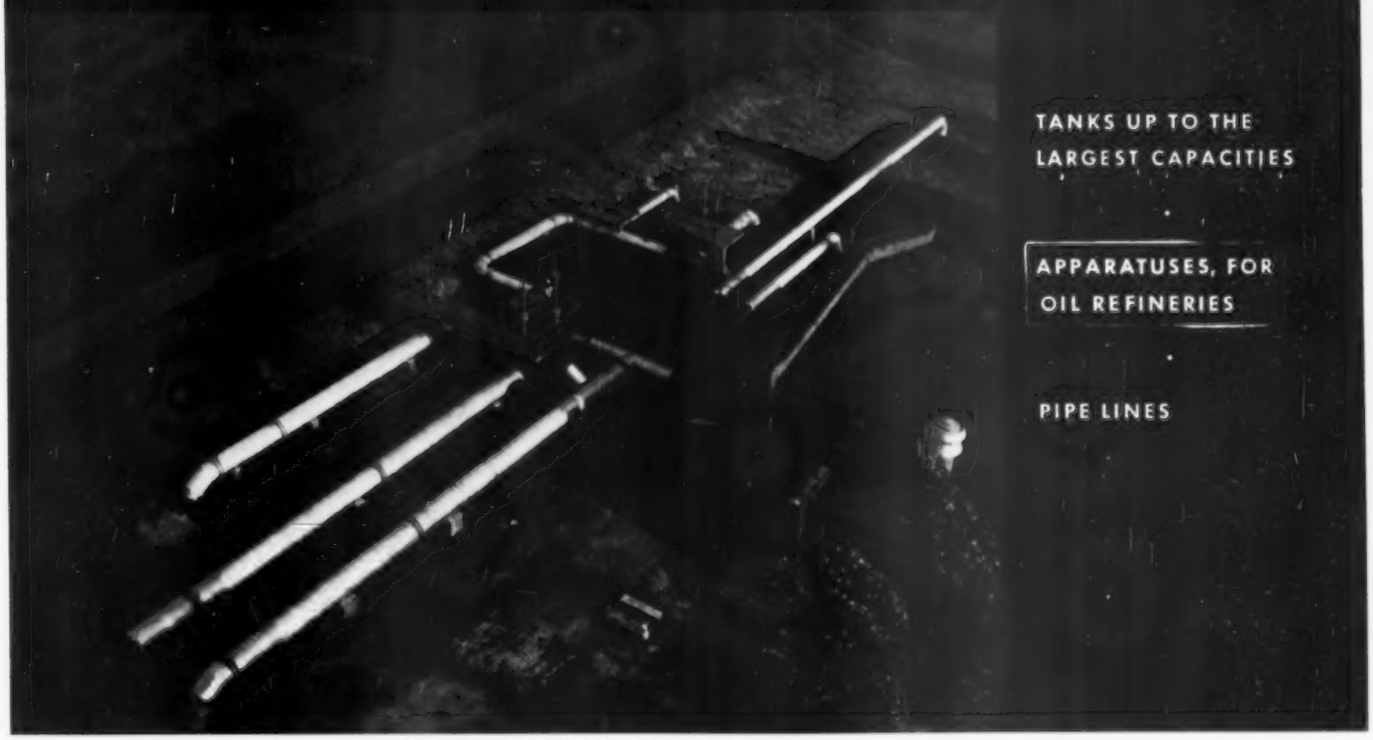

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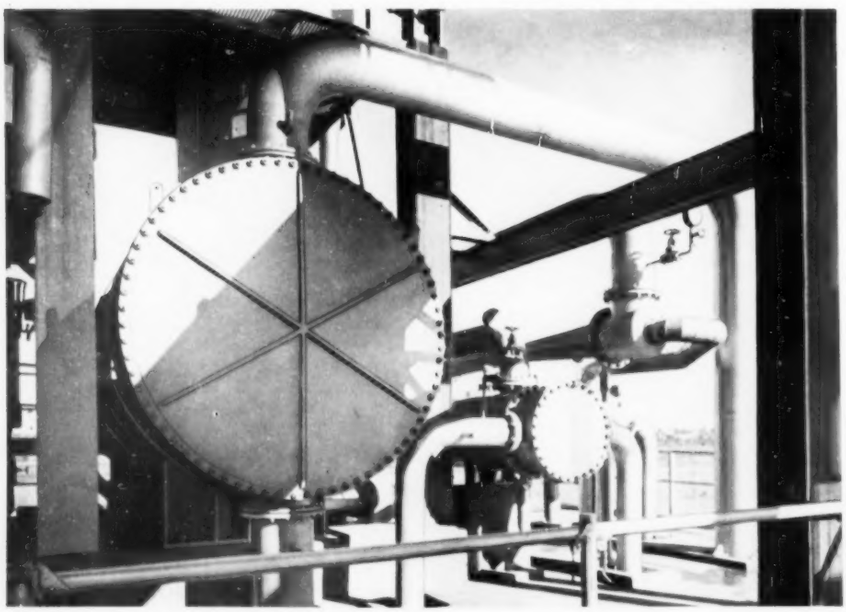
for water and oil vapours

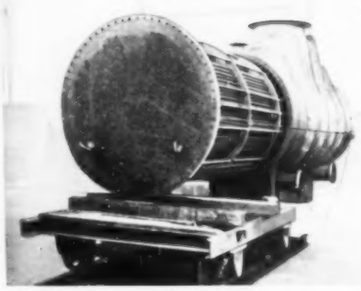
Provided with additional primary ejector sets (Boosters)

for the generation of a higher vacuum in the distillation column. In this case the non-condensable gas is drawn out by means of a multi-stage steam jet system with inter-condensers which, just as in the case of the large condensers can be constructed depending on the local conditions, either as surface condensers or as barometric condensers. In order to attain a high degree of economy, exhaust steam at low cost may be used for the ejector condensers and also for some stages of the air ejector sets. Since the proper operation of this equipment is very important for the whole distillation process, it is expedient to instal, instead of one set, two or more sets working in parallel, whereby, besides the advantage of more flexibility, a certain reserve capacity will be provided. A large number of plants in German refineries and many plants in the neighbouring foreign countries have been equipped with our sets.

Our manufacturing programme further includes heat-exchangers for liquid or gaseous media at normal and high pressures, for which the calculation of the cooling surfaces is also made by our own technicians.



Vacuum tower overhead system. The surface condenser with floating head. Photo Courtesy Mobil Oil.



Bundle 50" ø x 45' total weight 25 tons.

Vacuum equipment four stage triple element. Photo Courtesy Shell.

Every piece of equipment is designed in accordance with the relevant specifications (e.g. A-D specifications, ASME-Code, TEMA, HEI, etc.) and piping, flanges etc. are dimensioned in accordance with DIN or other foreign standards. With regard to the selection of materials, we comply as far as possible with the customer's wishes. Besides the normal steel specifications, we use stainless steel, non-ferrous and light metals for the manufacture of our equipment. Those parts of our equipment exposed to the danger of corrosion can be supplied with a protective coating, e.g. of stoved enamel or rubber.

For many years, jet pumps of our own improved construction have been used in the above mentioned installations. These jet pumps are extensively applied to the crude oil industry for many different purposes e.g. the transfer or pressure increase of liquids, gases and vapours by means of liquid or gaseous driving fluids; the practically noiseless direct heating of liquids by steam under various pressure conditions; the mixing of homogeneous and heterogeneous media; the evacuation of large size tanks and vessels; the scrubbing of gases; the injection of solids into gas or liquid streams and the condensation of vapours in single or multi-jet condensers.

The outstanding features of these jet pumps are firstly, the absence of any moving parts, which guarantees reliable operation and a minimum of wear and secondly, the practically unlimited selection of materials of construction.

For dropwise separation of liquids by means of their own pressure or of that of compressed gas or air, we supply spray nozzles made in various materials. Different types of spray nozzles were developed so that we can comply with the customer's specification with regard to the size of the drops or the shape of the cone dispersion.

Another very important field of our activities comprises the manufacture of:

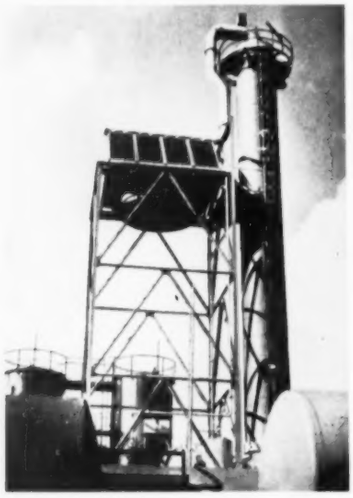
Oil burners of various types

for small and large size furnaces. This includes all accessories and complete pumping units.

(Continued from page 168)

contains corrosive agents. Difficulties in connection with the provision of proper cooling water suggest solving this problem by using other means for the cooling and condensation of petroleum products.

About 20 years ago the increase in petroleum processing capacity in Texas, California and the southern states of the USA focused attention on the use of air cooled equipment in view of difficult local water conditions. The provision of adequate cooling water in



Air-cooled distillation vapor condenser. Photo courtesy GEA Luftkuhlergesellschaft mbH, Bochum

this area is extremely difficult in view of the fact that during about $^3/_4$ of the year it does not rain, and that in the remaining quarter heavy rain falls lead to a silting up of the cooling water and a subsequent fouling of the heat exchangers. The construction of additional petroleum refineries forced a switchover from water to air as cooling medium. As a result and with the aid of technical developments an appreciable number of air cooled heat exchangers with pipe systems of large area are used in the crude oil industry since that time. It soon appeared that air cooling had the advantages of greater operating reliability, higher economy and more resistance against corrosion with longer operating times.

In Europe air cooled installations were preferably used in the chemical industry and in power plants for the condensation of turbine exhaust steam. During recent years the air cooler is getting a foothold also in refinery operations. For many plants built in connection with industrial post war reconstruction and the many new plants erected since 1948 the cooling water problem has been very acute.

Experience gained in the meantime with air cooling in Germany resulted in the installation during the last 8 to 10 years of thousands of air cooled condensers and coolers of small and large capacity. In their manufacture practically all materials customarily used in the industry were applied to constructing finned tube systems. Although in America the horizontal type of construction is normally used, the roof type construction was developed in Germany. This construction has appreciable advantages from the standpoint of heat economy and with regard to space requirements. The roof type construction of the air condenser requires only about 60% of the area of the horizontal type of construction and has further the advantage that free convection can be used in case the air fan fails.

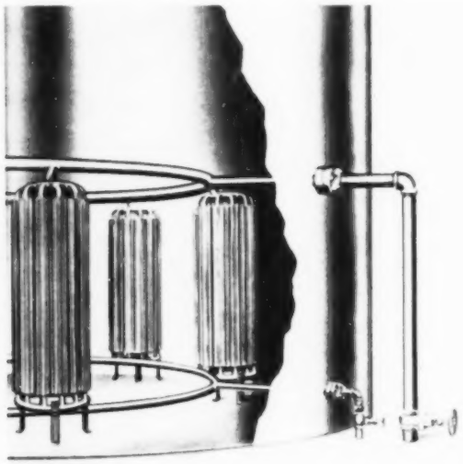
In view of the economic advantage of air cooled installations the application of these will steadily increase in all those industries which appreciate the value of an operation free of trouble and of maintenance.

In order to complete the picture of equipment manufacture we shall now turn our attention to the large size vessels. In the refinery field tanks should be mentioned in the first place since these play such an important role in refinery operations.

When designing a refinery, particular attention is to be given to the size and the number of tanks to be provided for the storage of crude, intermediate and finished products. The tanks for incoming and outgoing products should be so dimensioned that all fluctuations in the supply of crude and in the market demand of the finished products can be compensated for so that an uninterrupted operation guarantees the manufacture of products of uniform quality in the most economic way.

Selection of the type of tank construction is also of decisive importance for the economy and safety of the operation. For a long time the cone roof tank was preferred in Germany; however, in the last 10 years the floating roof tank is almost exclusively used for the storage of liquids containing volatile components. The use of this type of tank was not so much retarded by the problem of the floating roof itself as by that of perfect sealing of the annular space between

Tank yard with floating roof tanks. Photo courtesy Carl Spaeter GmbH, Hamburg



Brown Fintube tank heaters. Photo courtesy Friedrich Uhde GmbH, Dortmund

room and tank shell. Only recently the rubber and plastic industries succeeded in the manufacture of sealing materials of good resistance against oils and weather influences. Of the multitude floating roof shapes developed only a few were able to maintain their ground. The construction of these is varied in accordance with the purpose of application. Double-deck floating roofs are usually preferred for medium size tanks of a capacity up to 5000 m^3 (30,000 bbls) whereas generally pontoon floating roofs with a deck free floating on the liquid is used for tanks of larger size. A properly constructed floating roof shows the following outstanding features:

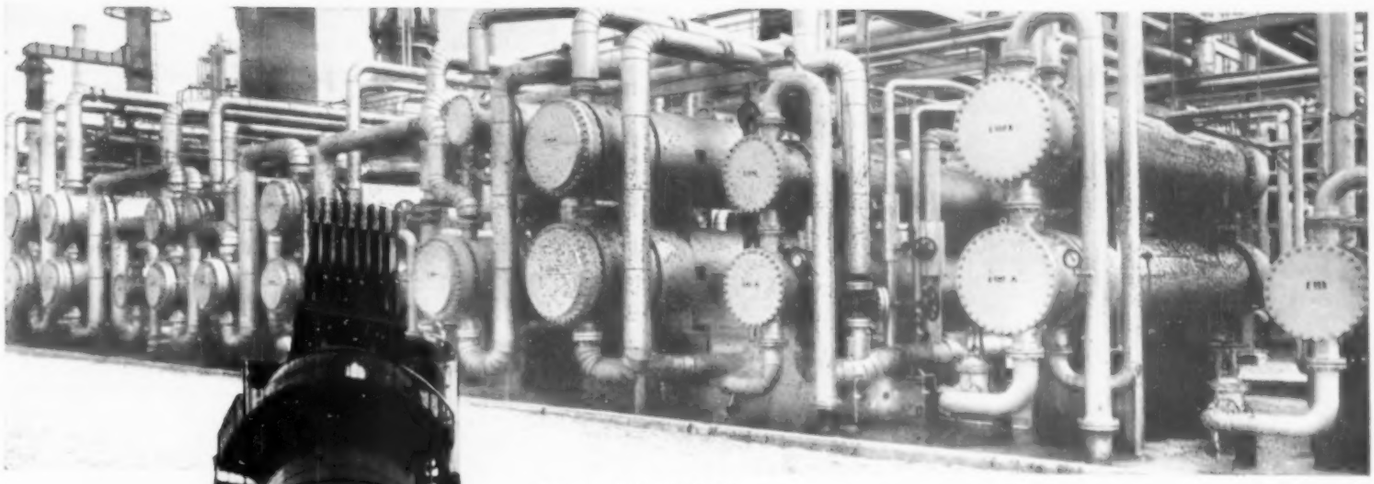
1) Small gas space without levers and rods decreases the danger of fires in the annular space.

2) The mechanism is located completely outside of corrosive liquids and vapors.

3) Sealing is protected from weather influences by means of sheet metal.

4) In normal operation sealing does not get in contact with stored liquid.

(Continued on page 178)



Koerver & Lersch built
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for ESSO refinery
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Atmospheric Destillation Tower
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Length 167 ft.
Weight: 180 to.
Material: Carbon steel,
Monel-and 13 % Chrom clad.

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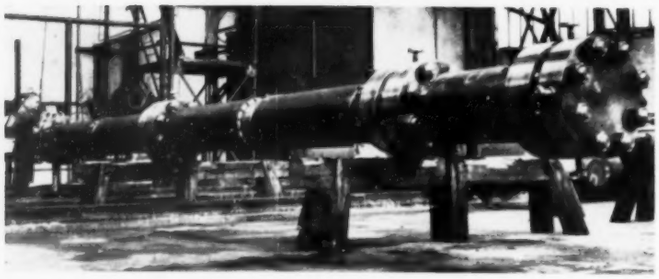


Seamless high pressure vessel of hydrogen-resistant steel. Photo courtesy Stahl und Rohrenwerk Reisholz GmbH, Düsseldorf

(Continued from page 176)

5) Sheet metal (see 3) reduces temperature fluctuations in gas space and therefore reduces breathing.

6) Mechanism is easily accessible.

7) A floating roof has a smooth appearance.

Floating roof tanks may, therefore, be considered as practically fireproof installations and consequently safety measures are much less essential for that type of tank than for cone-roof tanks. Since under the most unfavorable conditions only fires in the annular space might occur it normally suffices to provide facilities for the filling with foam of the small annular space between tank shell and rim.

Unfortunately, fire and police regulations vary so much in different countries that it is hardly possible to specify generally applicable measures with regard to the scope of required safety precautions.

Shell spraying required for cone roof tanks is supposed among other things to avoid a volume increase of a vapor mixture due to temperature increase in case of a neighboring fire. Under certain circumstances it could even occur that the expelled vapor mixture due to mixing with the atmosphere becomes explosive and would, therefore, constitute a potential danger. The ignition of such an expelled vapor mixture by a spark without explosion might easily lead to a fire in this tank. In the case of floating roof tanks which have no appreciable gas space this danger is practically negligible.

Heating of the liquid contents of a floating roof tank to near the boiling point which might result in a dangerously increased evaporation is hardly to be expected even in case of a practically empty tank and of a fire extending over an extended period. The ratio between the heat absorbing surface and the tank contents is comparatively small and always remains constant. Shell spraying for floating roof tanks is, therefore, not necessary and is generally not required by fire or police regulations.

The appreciably lower cost of safety devices required for floating roof tanks compensates in most instances for the extra cost of such a tank. With a fraction of the cost of large stationary fire protective installations, in particular in case of large tank yards, movable fire fighting equipment can be procured which allow a concentrated combating of fire and an effective protection of neighboring tanks.

Aside from the increased safety and the lower cost of the required safety measures the main purpose of floating roof tanks is generally the reduction of evaporation losses. These losses consist of breathing and filling losses. In the case of cone roof tanks the larger part of the breathing losses are caused by the temperature differences between day and night. The filling losses are caused by the fact that a vapor-air mixture is expelled to the atmosphere by the incoming liquid and air sucked in when the tank is emptied. In the case of floating roof tanks there is no variable gas space depending on the amount of liquid present in the tank and, therefore, these losses do not occur.

In this connection reference should be made to gasholders which are used for the economic and suitable storage of industrial gases in refineries. They are of particular importance for petrochemical plants.

For storage of fuel gas telescopic gasholders are generally used with water or oil seals whereas for the storage of process gas stationary gasholders are used. Nowadays pressure storage tanks are more and more used for technical gas of all different kinds. These tanks are usually constructed in the form of spheres or cylinders.

Before concluding this section about large size storage tanks reference should be made to the requirements of a properly laid out water system in a refinery. For reasons of operating reliability it is often advisable to install an elevated water tank to be used for emergency purposes in case of power failure.

Normally tanks, gasholders, elevated tanks and the like are self-supporting plate constructions for which plates of medium wall thickness are used. As far as thin walled plates are used for gasholders, plain steel structures carry the load. More complicated steel structures are required for roof rigidity. Stairs and platforms are to be provided in the design with a view to accessibility of the tank and for regular repainting on the inside and outside.

Steel structures required for a large size storage tank are prefabricated in the shops whereas the plates are only bent and partly prepared for the welding at the building site. The assembly of a large size tank is a typical construction job to be carried out at the building site. In view of the extended time required for the field construction of such tanks the design and the order placement should already be effected in the early stages of the design work.

Modern petroleum processes require in many instances special vessels like reactors and regenerators which often in view of the operating conditions to be expected must be designed for high, even extremely high operating pressures. We here enter the field of the manufacture of heavy and high pressure equipment which calls for a highly developed shop technique and great reliability. Pressure vessels weighing from one to several hundreds of tons have to be manufactured in the shops true to size and free of stresses, and to be transported to the building site and erected there.

Only those who have seen those giants during the process of manufacturing can visualize the extent of responsibility and technical ability which are required of all those participating in this work from the design up to the completion of the erection.

The question of material is one of the most important points in designing vessels and apparatus for all refineries. When planning oil refineries the process engineer is primarily guided by his knowledge of the chemical and physical process and the thermodynamics. The designing engineer has to find the most economic shape and size of the apparatus required for the process.

Due to their experience gained in the course of many years German steel producers have qualified for the fabrication of especially big and complicated apparatus for the oil industry. Their large production of pig iron and steel is the basis for all supplies. The melting program of the open hearth and electric steel mills covers all standard, unalloyed, and alloyed steels. Fine grained steels weldable without preheating, with high yield point, free of brittle fracture and cold workability were developed in the research departments.

Plates and flanges produced in their own heavy and medium plate and flange rolling mills are subsequently treated in large flanging and welding shops. Vessels, columns, and apparatus are fabricated in these plants from structural plates, boiler plates, clad and austenitic plates.

Qualified welders guarantee correct fusion welding according to the requirements of the T.U.V. (Technical Supervision Association), Lloyds' Register of Shipping, Class A I, American Bureau of Shipping, Germanischer Lloyd, Norske Veritas, Deutsche Bundesbahn, etc. For vessels and apparatus subject to high stresses weld efficiency v = 0.9 or v = 1.0 is used.

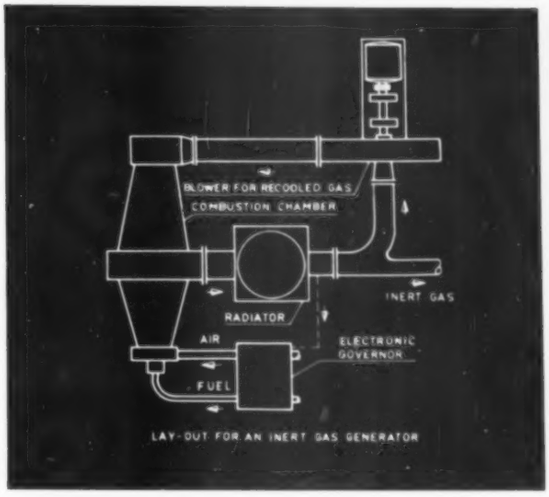
In the manufacture of high pressure equipment with wall thicknesses of 40 to 50 mm ($1\frac{1}{2}$ to 2 in.) until recently the forged vessel was preferred. For that reason the size of these vessels was limited by the production of the forging blocks and by the transportation of the finished material to the building site. Welding of thick walled vessels at the building site during the erection was not possible. Nowadays the German steel works have created possibilities by means of new investment and developments to manufacture vessels up to a wall thickness of 250 mm (10 in.) of any desired size on the building site or they may be partly fabricated in the shops.

In many cases it may appear advisable for reasons of economy and quality to manufacture thick walled vessels in their proper shape by means of welding. If vessels of an exceptional size or shape have to be made no further considerations with regard to the manufacturing method are required since a welded construction is the only possible one.

Indepensable requisites for the manufacture of plates of larger thickness than 75 mm (3 in.) are extremely large rolling mills, for their further processing machines of very high capacity and for their welding, installations which meet the most recent technical requirements. Futhermore, annealing furnaces or installations of appreciable size for the heat treatment of completed vessels must be available. Finally the most reliable instruments for the non-destructive testing of welding seams are required in order to detect faults and to assure maximum safety.

(Continued on page 186)

Plants for producing inert gas from gaseous or liquid fuels by a stoichiometric combustion process, e. g. for oil refineries, fuel depots, chemical industries, varnish production, etc.



LAY-OUT FOR AN INERT GAS GENERATOR

Inert gas consists of:
80 – 92 vol% of nitrogen,
3 – 15 vol% of carbon dioxyde,
3 – 4 vol% of water vapor,
0.2 – 0.3 vol% of residuous material
$(O_2 + CO + H_2 + C \ldots)$

Operation. Air is fed to the fuel by an electronic feeder in stoichiometrically measured quantities, and then the mixture is burnt in the combustion chamber. The hot product of combustion (inert gas) is mixed with cooled inert gas while still in the combustion chamber so that the inert gas will leave the combustion chamber at a temperature of 600 – 800° C. A cooler cools the inert gas to approximately the ambient temperature. By means of a blower part of this cooled inert gas is lead back into the combustion chamber. The electronic control (relation of fuel to air) is carried out automatically by continuous measurings of the content of residual oxigen.

Capacity. We generally build plants of a maximum capacity of 300 - 1200 cu. ft. min., we can, however, also manufacture larger and smaller ones. The inert gas can be produced with a pressure of up to 140 psi, in this case it is especially suitable for the cooling of those tanks, reactors, and columns which after being shut down are liable to explode.

Fuel. The fuel may consist of combustible gases and liquid ashless fuels. The burner is designed to burn low-caloric gases with calorific values of down to 19 B. t. u./cu. ft. °F. Because of their low exhaust temperature these gases cannot be burnt in the conventional burners.

Required Energy and Space. Krauss-Maffei inert gas plants of a capacity of 600 cu. ft /min. need an area of about 45 sq. yd. They are not bound to any definite basic form. The energy required is about 1 kWh/35 cu. ft. of inert gas.

Life and Maintenance. The blower bearings of the Krauss- Maffei inert gas plant are designed for long life.
When using liquid fuels the nozzles generally have to be renewed after a one-year service.
The control instruments have to be checked and adjusted annually, but they will last several years.
There are no further parts exposed to wear which in any way influence the life of the plant.

Characteristics. According to size the plants will produce pure inert gas within 2 - 5 minutes after starting. The purity of the inert gas product is continuously checked and controlled by the governor unit. If the adjusted purity values are unexpectedly surpassed the plant will stop immediately or blow off into the open for a while. An ingenious electrical connection between automatic governor unit, ignition- and starting device, flame control, and blower drives protects the whole plant against operational mistakes.

KRAUSS-MAFFEI
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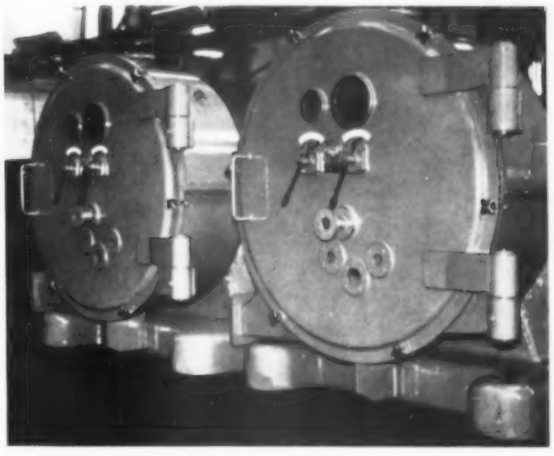
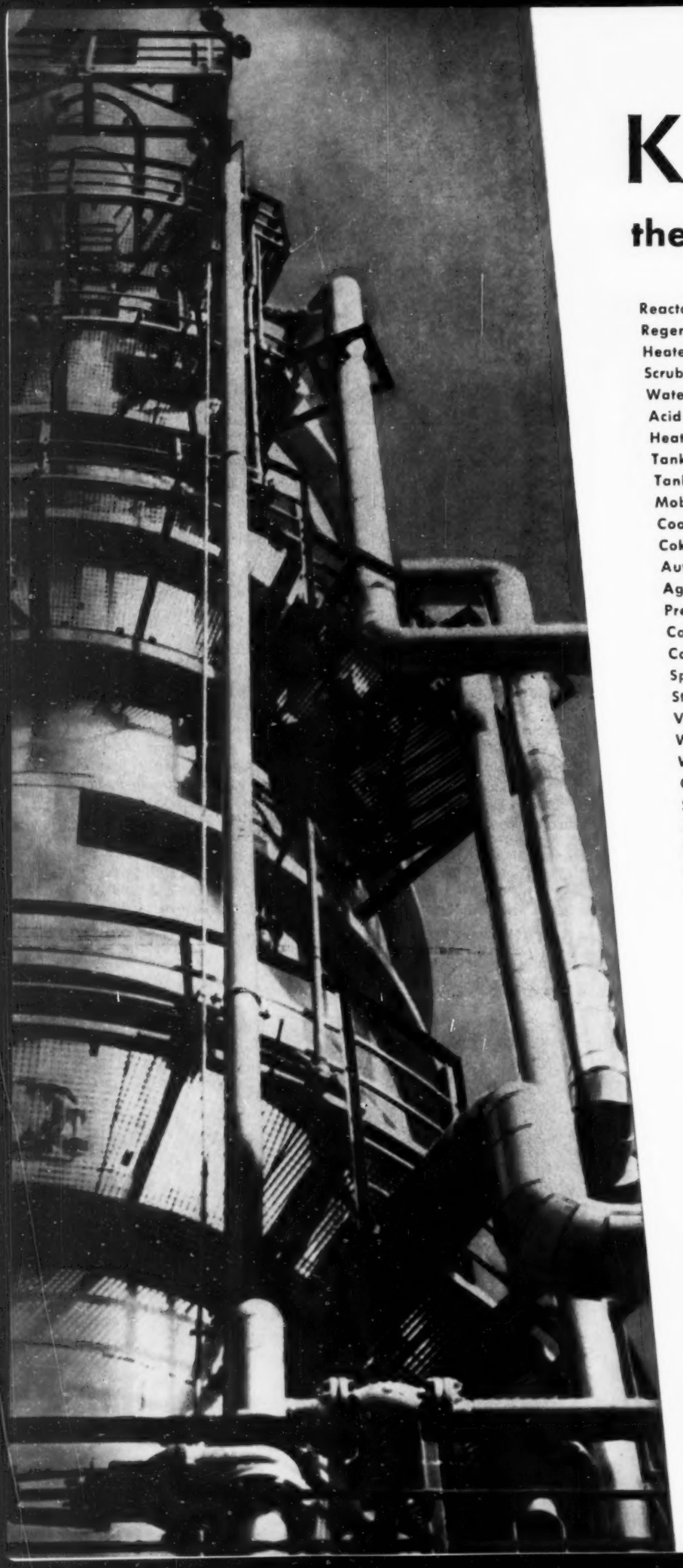
Special automatic or continuous centrifuges for deparaffination

Standard or gastight explosion-proof design for all capacities and every kind of processing.



Technical information available with
KRAUSS-MAFFEI - IMPERIAL
München-Obermenzing, Tannenweg 4



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the Petroleum Industry

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Acid separators
Heat exchangers
Tankers
Tank wagons
Mobile cranes
Coolers
Coking retorts
Autoclaves
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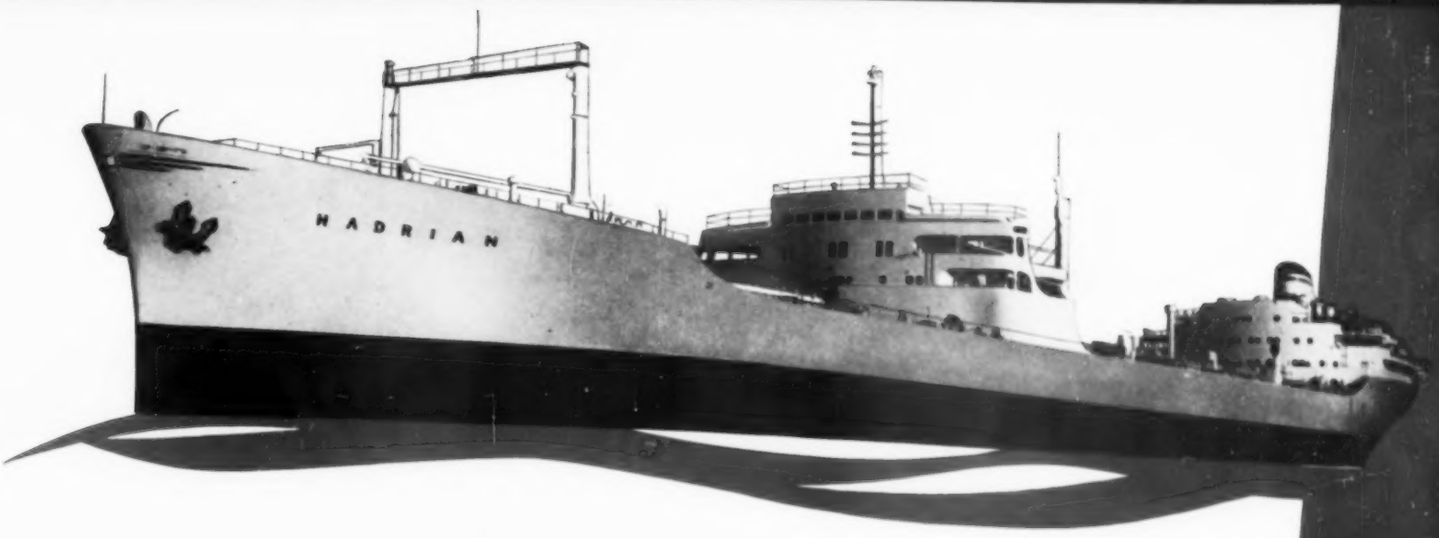
Columns
Column trays
Speed reducers
Stationary Diesel generating sets
VERDUR alloy for hard-facing drill bits
WIDIA carbide flow nozzles for drill bits
WIDIA carbide valves and jet nozzles
Compressed gas receivers
Storage tanks of plain and alloy steels
Pipes and tubes
Rolled products
Complete refineries, designed and erected in cooperation with other specialist firms

Crude Tower of clad steel NIROPLAT V 1 3 FAL/HII, 29.7 m. high, 4.2 m. in diameter, weighing 60 tons, manufactured by Fried. Krupp Maschinenfabriken Essen



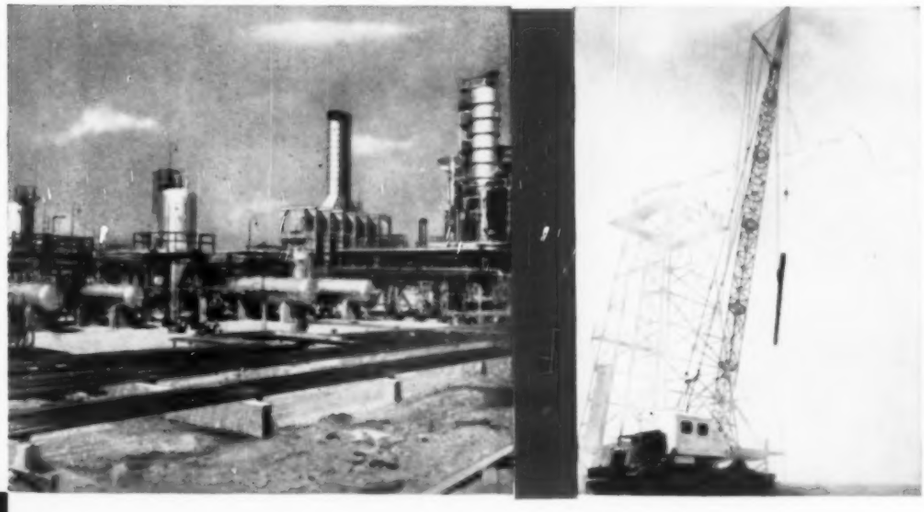
Turbine Tanker „HADRIAN", Norway's largest ship carrying 47,000 tons dw, built in 1959 for the Hilmar Reksten Shipping Company, Bergen, by the KRUPP owned shipyard AG „Weser" at Bremen

For almost 150 years, the name of KRUPP has been a synonym for high quality craftmanship and engineering prowess. It stands for pioneer work in many fields of industrial research, in engineering and production skills – work which has caused the name of KRUPP to be associated with engineering progress throughout the world.

KRUPP was first in developing the special-purpose and high-grade steels used today wherever crude is fractionated, cracked or distilled.

KRUPP will be found actively engaged on many building sites in Europe, in North, Central, and Latin America, and in the Middle East where petroleum refineries and petrochemical plants are to be erected, and has also delivered equipment to refineries set up in Columbia, Cuba, Egypt, Greece, Portugal, Venezuela, and Germany.

Large petroleum projects are being planned to cover the ever increasing demand for oil and many of them will be realized with substantial engineering help from KRUPP. At this time, two refineries are being built to boost oil production in West Germany, one designed to process 4.5 million tons and the other 2.5 million tons of crude annually. In both cases, KRUPP has been entrusted with the manufacture and supply of reactors, columns, heat exchangers, tanks, and structural steelwork. During the past 7 years, a total of 18 tankers, among them series of 6 and 4 units of the same class, left the KRUPP-owned shipyard AG „Weser" where more big tankers are under construction.



Refinery at Aspropyrgos, the first to be erected in Greece, with an annual crude capacity of 1.3 million tons. KRUPP supplied 70% of the equipment and the plant was completed in 1958 by a group of German firms.
Fried. Krupp Industriebau, Essen

Mobile cranes and hoists, also mounted on crawlers, for all work such as erecting drill rigs up to 60 m. high, laying of pipe lines, etc., manufactured by Krupp-Ardelt GmbH, Wilhelmshaven

FRIED. KRUPP · ESSEN · GERMANY

Agents in many Countries. In USA represented by KRUPP International Inc. 375, Park Avenue, New York 22/N.Y.

Tanks of different sizes with cone or floating roof,
Fractionating towers,
Reactors,
Distillation columns,
Cracking towers,
Absorbers,
Pressure tanks,
Spherical gas tanks,
Heat exchangers,
and all steel construction for these installations.

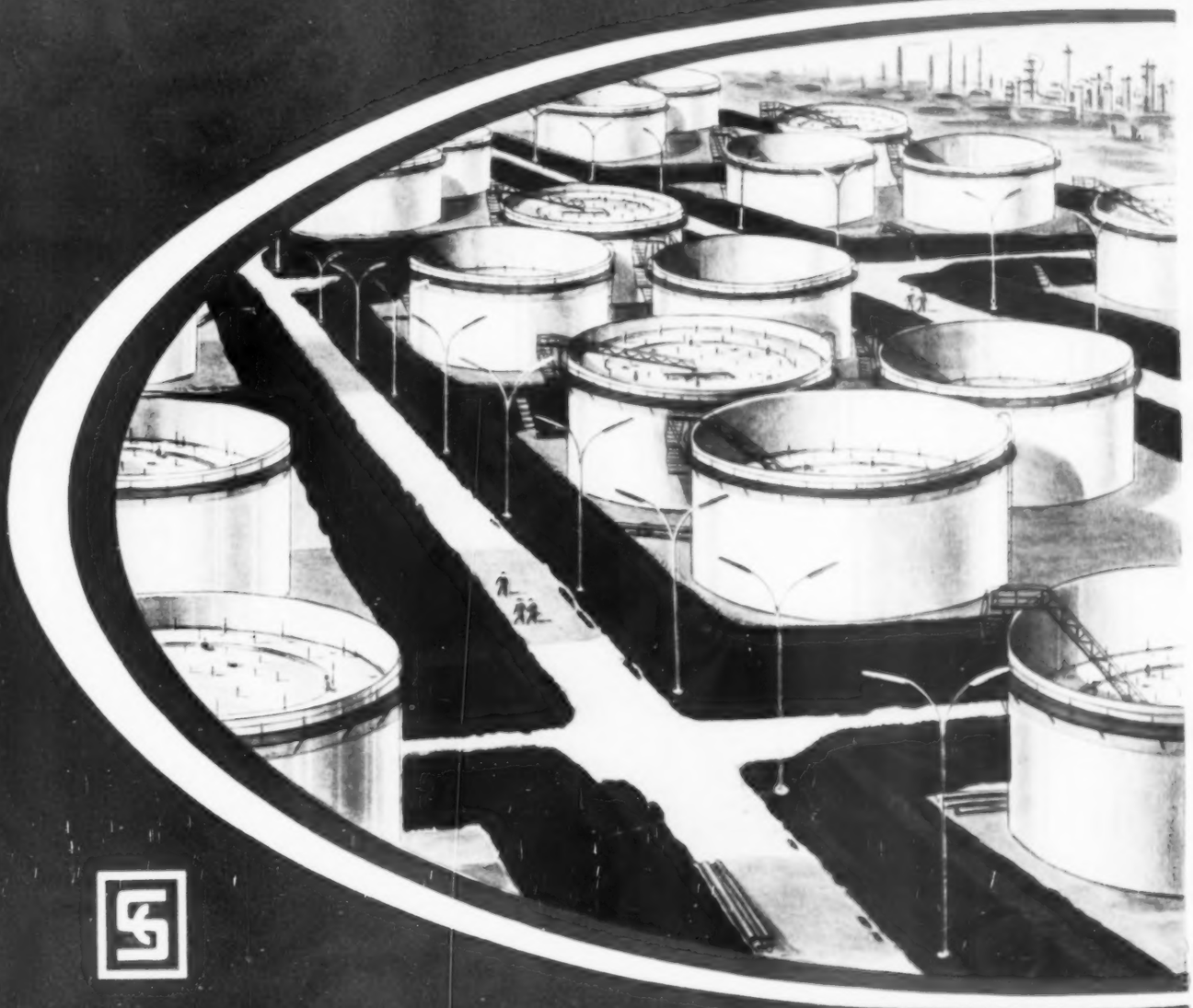
THEODOR GRÄBENER

WERTHENBACH KR. SIEGEN

ECONOMY AND SAFETY BY »WIGGINS«

FLOATING ROOF TANKS

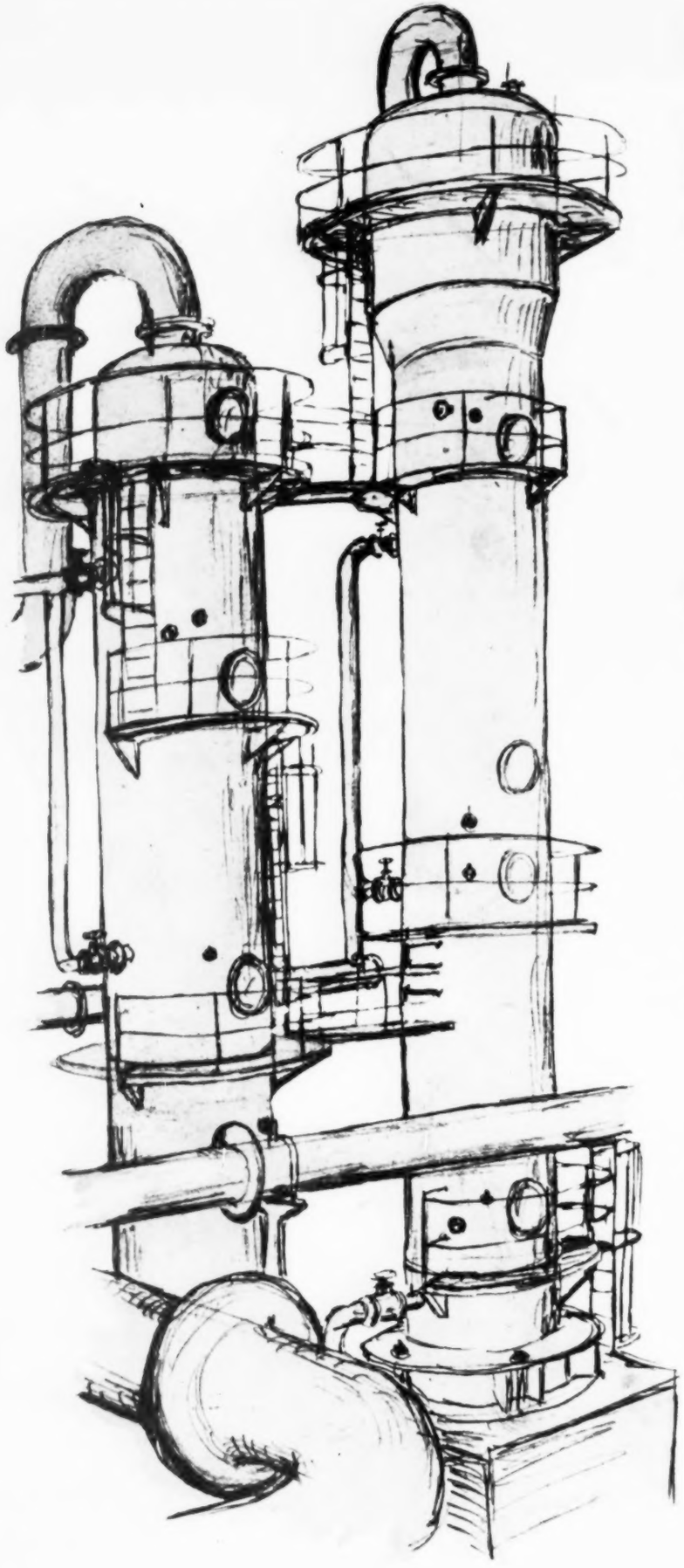
WITH SAFETY SEAL



PATENTS OF G.A.T.C.

CARL SPAETER · HAMBURG

GERMANY



We build

fractionating columns, strippers and scrubbers

with our exchangeable bubble trays of prefabricated parts-STREUBER system,

plain, light weight tray parts of uniform size, easily introduced through manholes, thereby eliminating the necessity of flanged column ring construction,
easy formation of passage through column,
trays easily adjusted for level mounting with adjustable depth of immersion,
simple and quick installation of trays on plain points of support,
high fractionation efficiency combined with high load capacity,
low tray weight and still extreme stability, therefore reduced cost,
applicable for any size column from a diameter of 1000 mm (3 ft 6 in.) upwards.

fractionating columns for low liquid loads

on the same principle, however with controlled liquid flow,

perfect distribution of even the smallest quantities of liquid,
long liquid passage way with continuous exchange,
uniform tray effectiveness with no damming up of liquid.

small diameter columns,

which, therefore, are not accessible; can still be easily assembled with tightly sealed exchange trays. (Kloß patent)

insertion of pre-assembled set of trays so that columns can be built without intermediate flanges,
trays can be easily inserted and removed,
tray sealing as such acts as additional exchange surface.

columns for sharp fractionation under vacuum

based on a new principle, suitable as well for batch as for continuous operation. (Kloß system)

high throughput,
sharp fractionation,
minimum pressure drop.

German and foreign patents and patent applications. All processes and methods were developed by our own organization. Installations are made in steel, stainless steel, copper, aluminum etc.

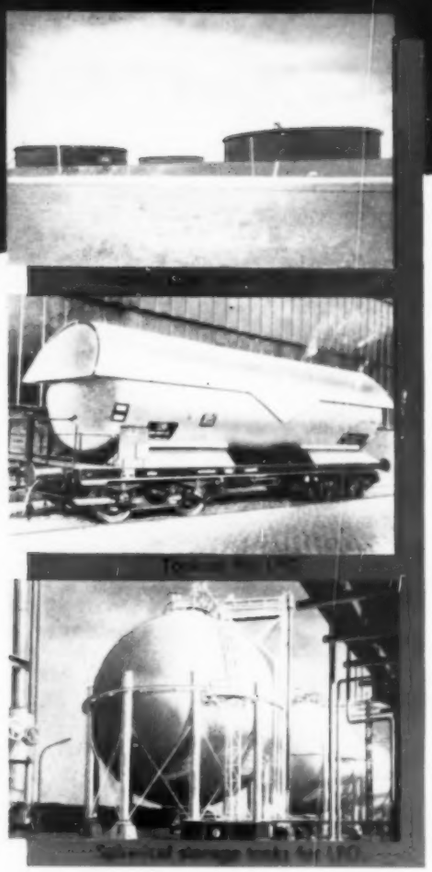
Foreign representatives wanted.

JULIUS MONTZ · HILDEN
RHINELAND
APPARATEBAU

Telephone 2224 – 2225 Telex 08 582 226

Equipment and tanks

for the crude oil industry



Deethanizer-Debutanizer
Height: 111 ft 6 in. Pressure: 341 psig. Temp.: 600° f

OUR MANUFACTURING PROGRAM:

Various types of fractionators, reactors, scrubbers, strippers, settling tanks.

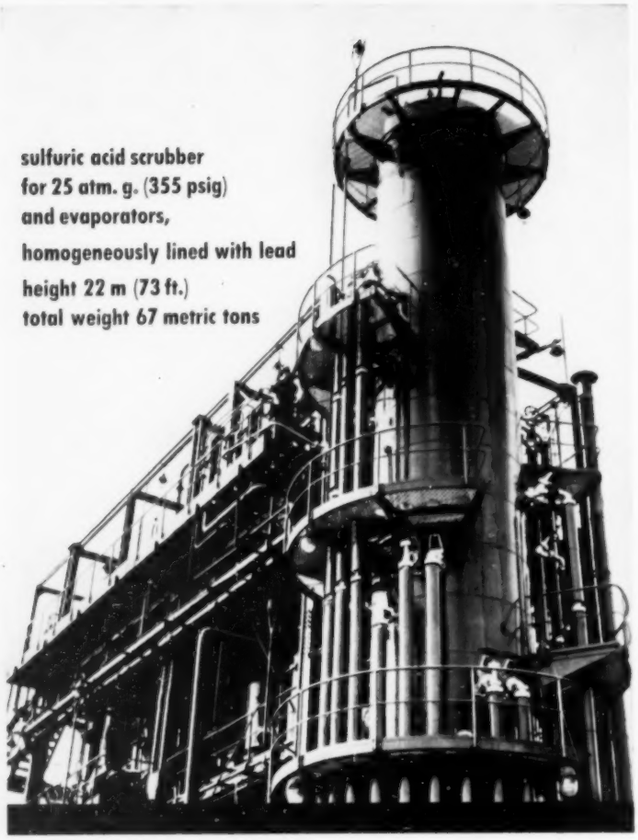
Various types of storage tanks for crude oil and products.

Pressure tanks for the storage of LPG (in particular spherical vessels).

Tankcars for LPG.

Loading racks, steel stacks, steel structures.

RHEINSTAHL UNION BRÜCKENBAU
AKTIENGESELLSCHAFT
WERK ORANGE · GELSENKIRCHEN


sulfuric acid scrubber
for 25 atm. g. (355 psig)
and evaporators,
homogeneously lined with lead
height 22 m (73 ft.)
total weight 67 metric tons

equipment made of steel
homogeneously lined with lead
equipment made of plastic material
linings with plastic material

The Petrochemistry, one of the youngest branches of the petroleum industry covers a field in which in recent years our products are extensively used. After years of research and experimentation we developed new lead alloys with greatly improved protective properties in chemical and thermal respect. Our new lead alloys hold their own even under the most critical comparison and show in technical and economical respect remarkable advantages.

We design and manufacture in our own workshops: scrubbers, reactors, agitators, heat exchangers, homogeneously tinless lead lined; also pipelines and valves for operating pressures up to 30 atm. g. (ab. 450 psig) and temperatures up to 400° F.

We manufacture in our plastic-department: epuipment, air conditioning installations, linings with plastics for tanks, valves, blowers and exhaustors of PVC and POLYTHENE.

SCHNAKENBERG · SEIT 1869 · CHEMIE-APPARATEBAU

Schnakenberg

Chemie-Apparatebau since 1869
Wuppertal-Barmen Rhineland · telex 08512826

(Continued from page 178)

To begin with particular attention must be paid to the selection of materials. It is absolutely essential that the material has an exceptionally good weldability and safety against fracture with a view to the welding of large cross sections. This is particularly essential for those parts which can only be assembled at the building site. Although investigations in this field are still going on throughout the world valuable views have already been formed which should be given serious consideration in the selection of the steels to be used. The further processing of thick plates, i.e. the shaping and welding thereof depends on the type of vessel. For the manufacture of large cylindrical pressure vessels two or more ring sections are required the bending radius of which should correspond to the diameter of the vessel. By means of longitudinal seams the properly bent sections are welded together to form a ring. By welding together several of these rings vessels of the desired length can be manufactured. Perfect assembly of the individual sections is of course only possible in case shaping is done with a high degree of accuracy.

After the thick plates are bent and in exceptional cases before metal cutting of the edges is done as a preparatory measure for welding the plate is generally clamped into a heavy shaper.

If steel for thick-walled pressure vessels is selected on the basis of the above mentioned viewpoints and first class auxiliary means (like e. g. in the case of manual welding good lime coated electrodes) are available welding itself nowadays does not present an extraordinary problem. It goes without saying that extensive experience with welding is required. As an example it might be mentioned that a thorough knowledge of the occuring stresses is essential for a successful welding of plates with a thickness of more than 75 mm (3 in.). Thinner plates may warp resulting in a decrease of the stresses during the welding. With thick plates care should be taken that by means of a suitable welding technique the stresses do not exceed a certain limit under any circumstances.

Due to the application of automatic welding processes avoiding of the occurrence of welding stresses in the shops is much simpler.

With regard to the welding of plates with a thickness of more than 75 mm (3 in.) particular attention should be paid to adequate preheating. When using relatively soft unalloyed steel a preheating to 50 to 60° C (120 to 140° F) is recommended. If however, Mn-alloyed steels of an approximate composition of St 52 are used, higher preheating temperatures of say 100 to 150° C (212 to 300° F) are required. The transformation behavior of the steel is in each individual case decisive for the preheating temperature.

Building site weldings have often to be carried out under difficult conditions and, therefore, fully automatic processes can hardly be considered for this type of work. The preheating of the seam zone must be given particular consideration in the case of building site welding. Depending on the available possibilities suitably constructed gas burners or electric preheating facilities should be provided. Furthermore, the welding area should be protected against atmospheric influences.

It is, of course, logical that all parts should be prefabricated as much as possible in the shops. The powerful lifting equipment nowadays available makes is possible that extremely heavy and large plant parts can now be handled at the building site.

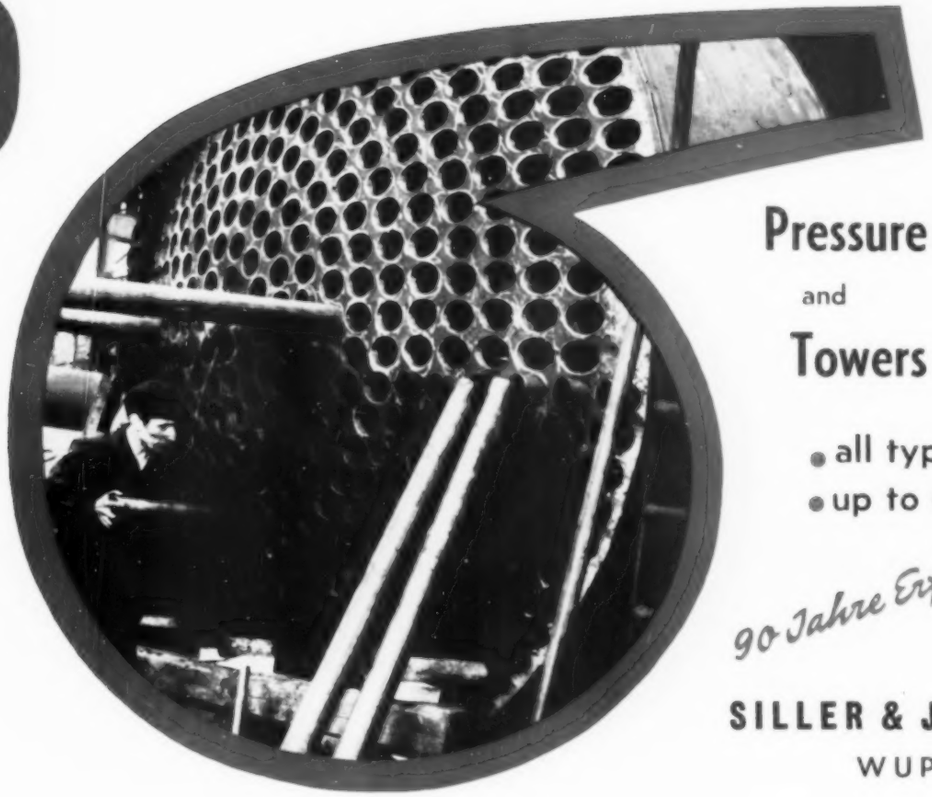
It will, of course, be clear that heat treatment following the welding cannot be executed easily at the building site. In any case it should be possible to accurately measure the temperature of the vessel wall during the annealing by means of a large number of pyrometers. Those instruments show whether the temperature increase up to the prescribed annealing temperature took place at a uniform rate and whether the annealing temperature was maintained during the desired period and the cooling was gradual.

A 400 kVA X-ray equipment is adequate for the nondestructive testing of welding seams for plates with a wall thickness of up to 80 mm (3 in.). Usable pictures can be obtained with the radioactive isotope Co 60 for plates up to about 110 mm (4½ in.). The range of application of a betatron begins with a thickness of about 80 mm (3 in.). For that reason betatron testing should be considered first for the testing of pressure vessels considered in this section.

Additional valuable data with regard to the condition of the weld can be obtained by means of ultrasonics.

The technique required for perfect shaping and welding of plates up to a wall thickness of 250 mm (10 in.) as well as the reliable testing of the welding seams have now advanced in Germany to a point that without hesitation the various companies may be entrusted with difficult problems.

FOUNDED 1867

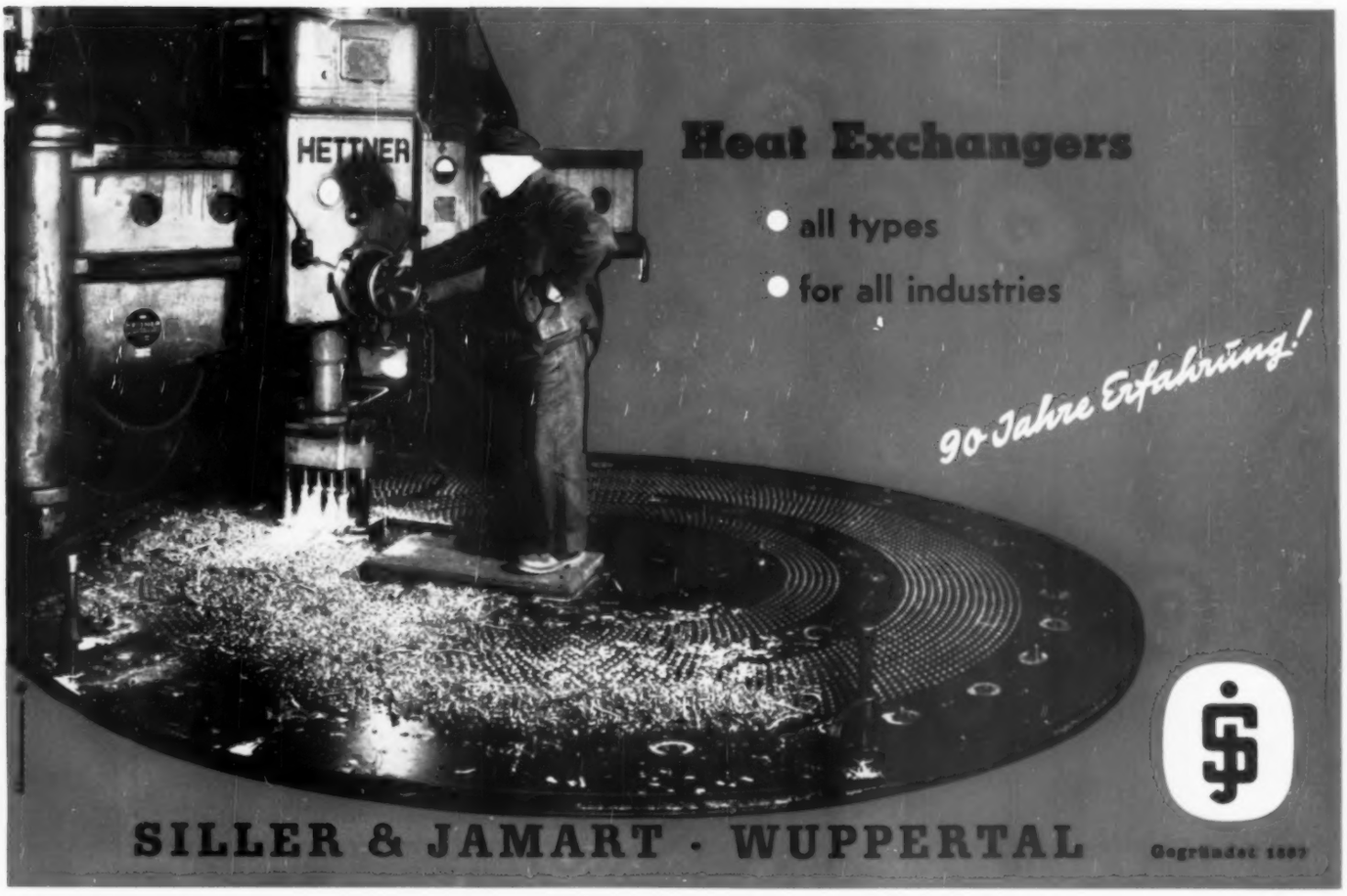


Pressure Vessels
and
Towers

- all types
- up to 60 tons

90 Jahre Erfahrung!

SILLER & JAMART
WUPPERTAL



Heat Exchangers

- all types
- for all industries

90 Jahre Erfahrung!

SILLER & JAMART · WUPPERTAL

Gegründet 1867

HIGH PRESSURE VESSELS
High pressure compressors
High pressure pumps
High pressure valves and fittings
High pressure heat-exchangers with longitudinally finned tubes
High pressure piping systems and building of complette high pressure plants for the hydrogenation of heavy oils, and for the generation of synthesis gas for the chemical industry.
UHDE
FRIEDRICH UHDE GMBH DORTMUND

horton sphere for butane storage
69.7' i. d., 32000 bbls., 93,9 psig.

Tanke
tanks

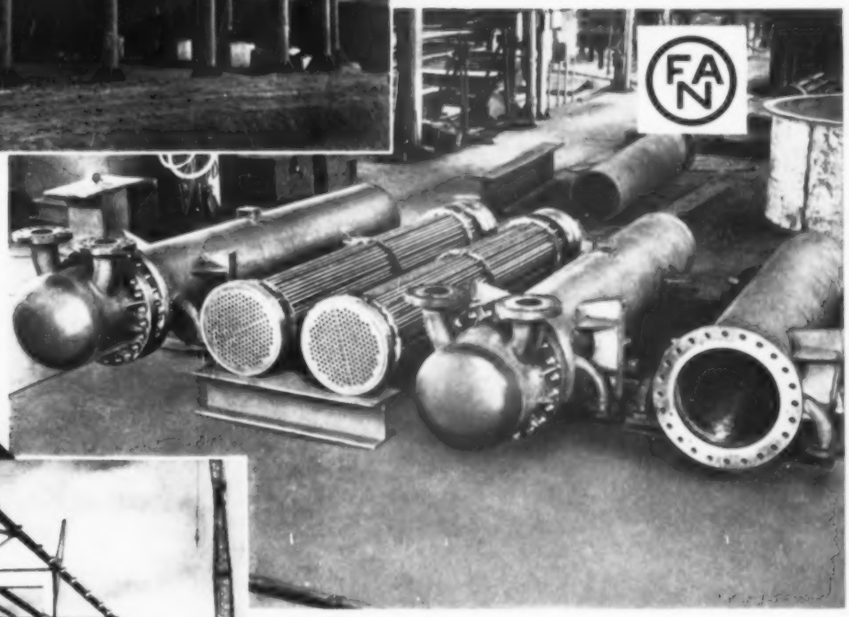
Druckspeicher
tanks for storage under pressure

Gasbehälter
gasholder

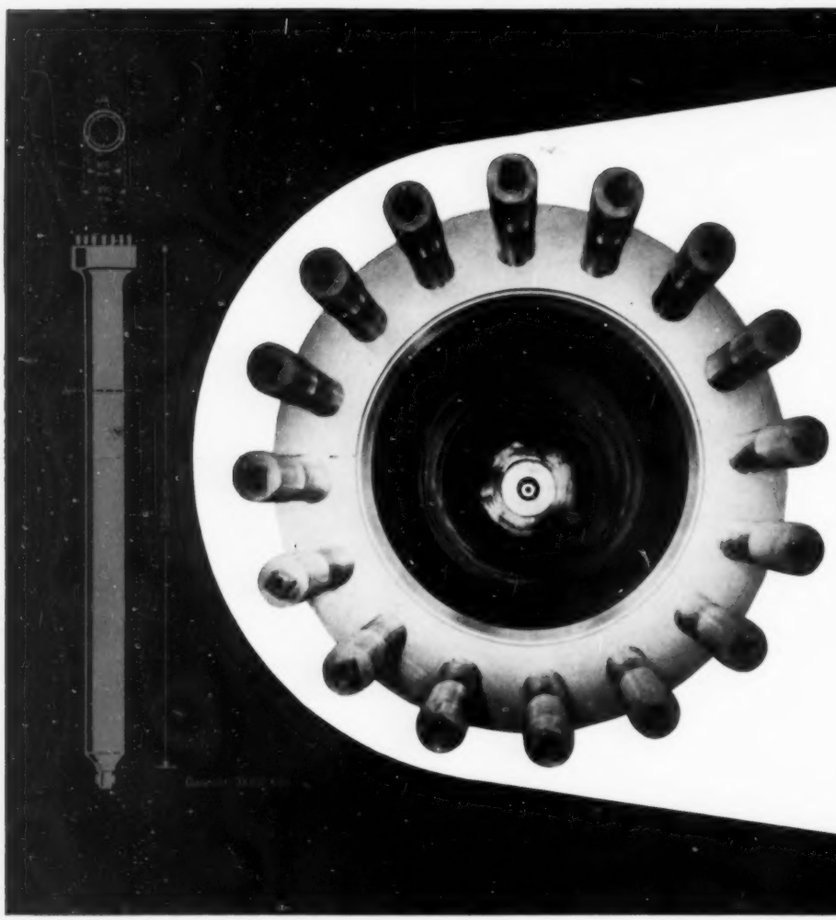
Wärmeaustauscher
heat exchangers

Schwere Blecharbeiten
heavy walled vessels

Stahlkonstruktionen
steel-structures



F·A·NEUMAN ESCHWEILER „WESTERN GERMANY"



High Pressure
Containers and Tubes

seamless forged
seamless pressed
seamless drawn

In the Chemical Industry today, the development of Processes has demanded plant construction suitable for high working pressures with either high or very low temperatures.
The requirements of these processes in the fabrication of Containers and Piping neccessitates use of high quality steel, selection of material and fabrication is made from three principal processes in our works, according to each individual unit requirement and operating condition. Our capacity being up to maximum original ingot weight of 120 tons (metric).

Stahl- und Röhrenwerk Reisholz GmbH.
Düsseldorf-Reisholz

Equipment and Columns for the Petroleum Industry

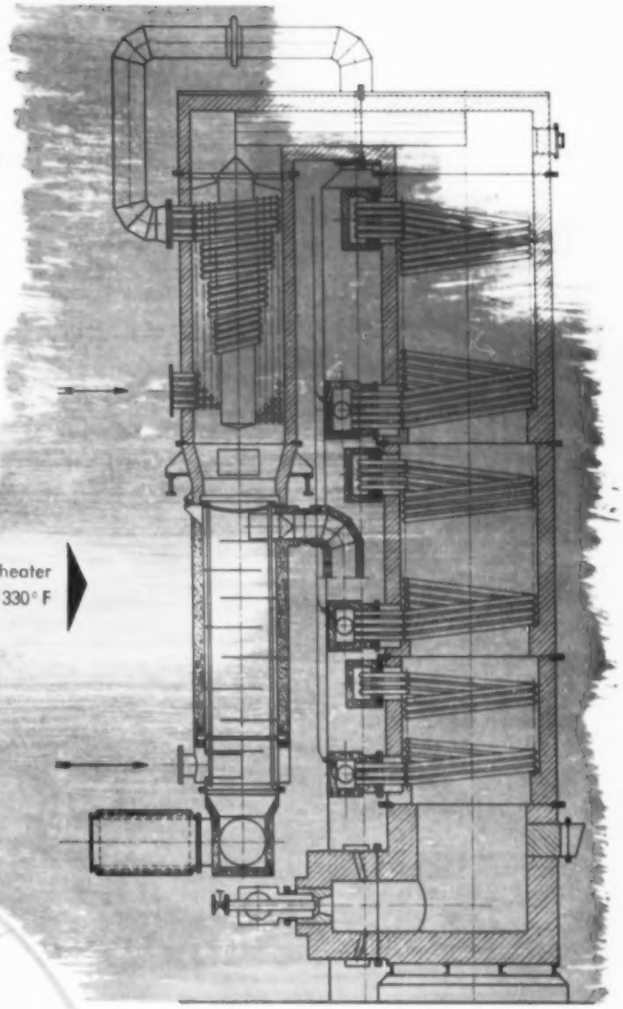
Part of a plant for treating petroleum products

Internal view of a column with bubble cap trays

Samesreuther & Co., G.m.b.H., Butzbach/Germany
Equipment and complete plants for the chemical industry

For Your High Temperature Gas-to-Gas Heat Exchange Applications

Designers and fabricators of fired heaters, heat exchangers and metallic recuperators for air, steam, methane, hydrogen, carbon-dioxide and other gaseous media. Preheats to 1800° F.



Schematic drawing of a recently completed Steam Superheater for 11 tons hr. Preheats from 680° F to 1330° F

SETREM
SOCIETE D' EQUIPEMENTS THERMIQUES ET DE RECUPERATEURS METALLIQUES
7 AVENUE DE L' OPERA
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METALLURGICAL ENGINEERS
5-15 CROMER STREET
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THE GRISCOM-RUSSEL-SCHACK-COMPANY INC.
901 RIDGE AVENUE
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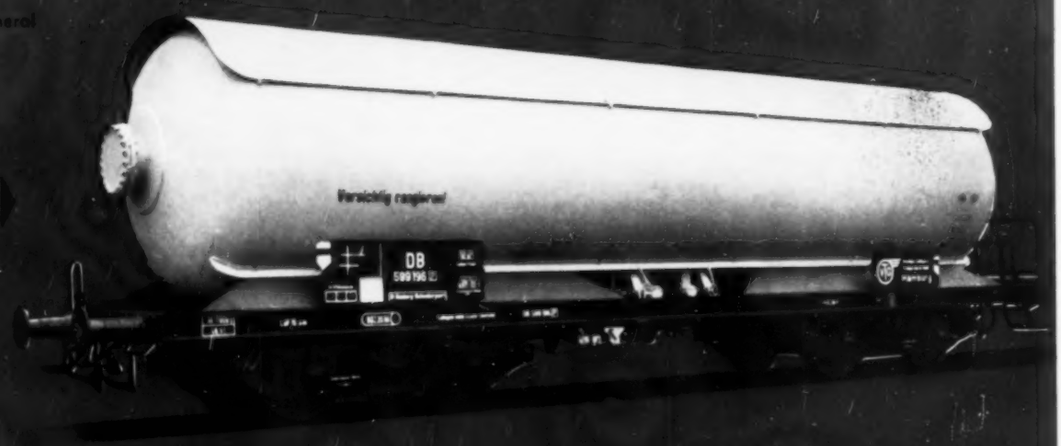
SEAG

SEAG freight cars are the answer to your traffic problems. SEAG has design and production facilities to suit any requirements.

13,000 gal. tank car for general service
Light weight 48,000 lbs.



The SEAG Car Division manufacture freight cars only. This deliberate restriction has resulted in a highly specialised design and production which ensures that the most diverse requirements in this line can be served in the most advantageous and economical way.

SEAG freight cars are now built under licence in seven countries.

The SEAG Pressing and Drop Forging Division manufacture railroad car accessories to specifications of all leading railroad companies in the world as well as pressings and forgings for the oil industry.

RHEINSTAHL SIEGENER EISENBAHNBEDARF

AKTIENGESELLSCHAFT · DREIS-TIEFENBACH/SIEGEN · GERMANY

RUHRSTAHL

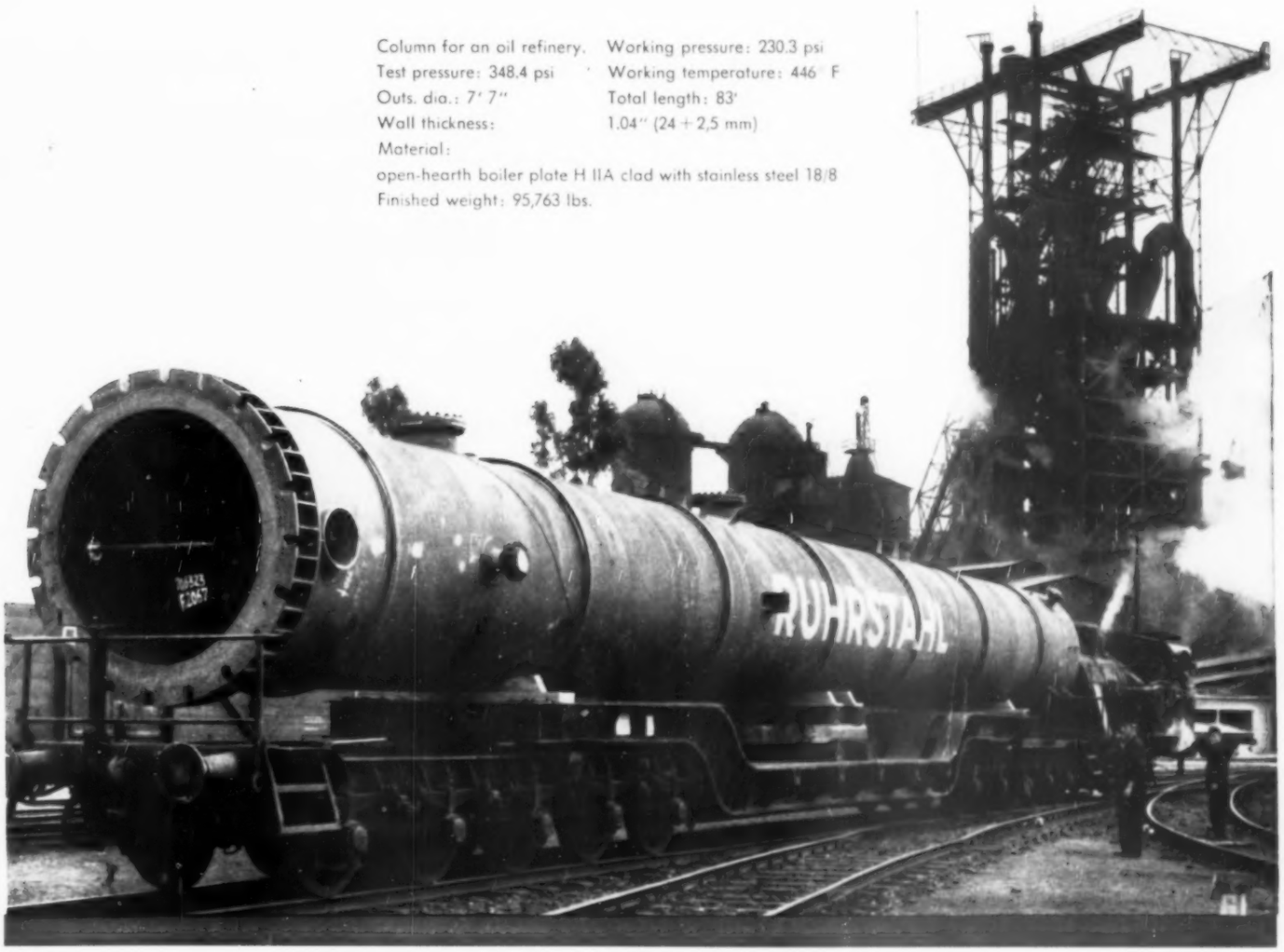
supplies

OIL REFINERIES *with*

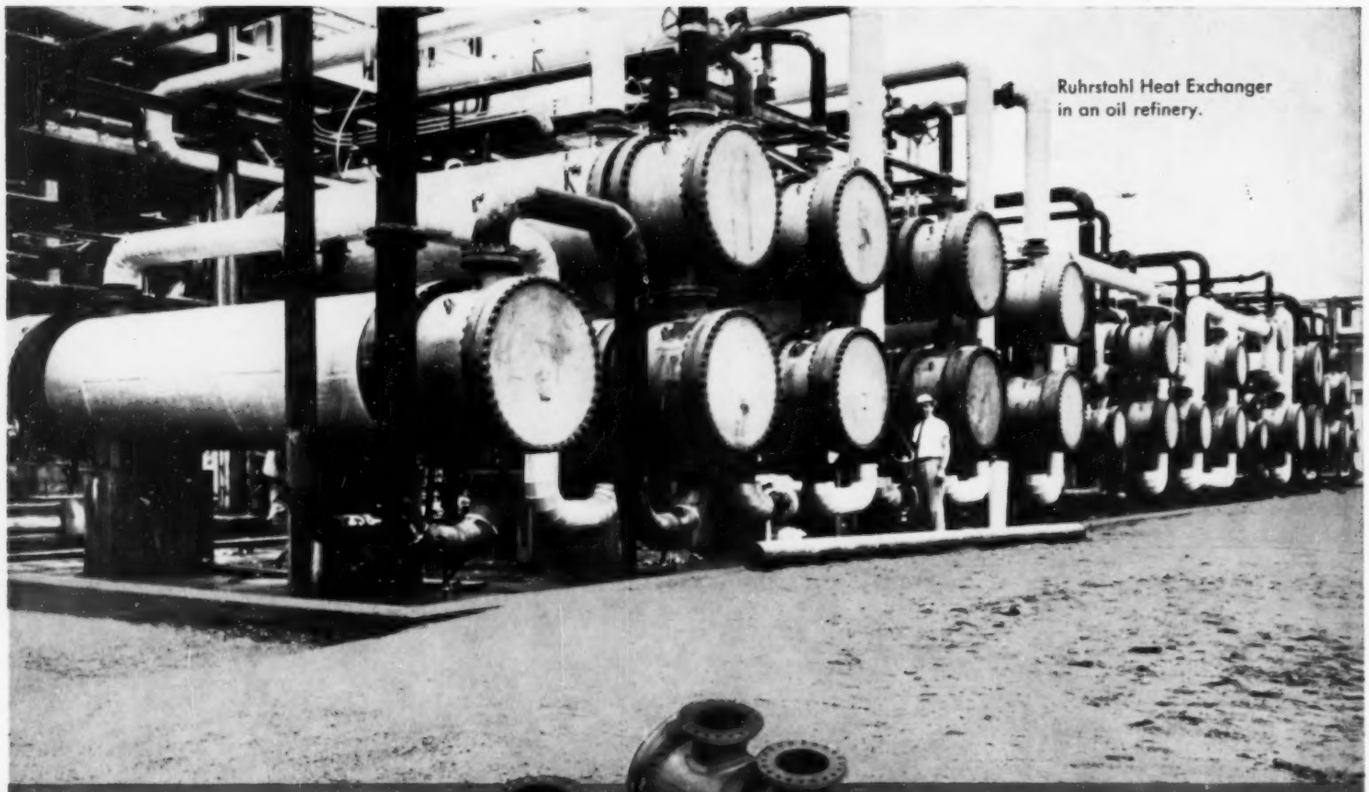
columns, reaction vessels, petrol condensers and coolers, oil coolers and oil heaters oil heat exchangers, reboilers, tank heaters, tubular coil systems strippers, pressure vessels up to the largest dimensions made of alloyed or unalloyed steel produced in our own steel melting shop with or without interior linings of corrosion resisting material or boiler plate according to all German and foreign specifications

Column for an oil refinery.
Test pressure: 348.4 psi
Outs. dia.: 7' 7"
Wall thickness:
Material:
open-hearth boiler plate H IIA clad with stainless steel 18/8
Finished weight: 95,763 lbs.

Working pressure: 230.3 psi
Working temperature: 446° F
Total length: 83'
1.04" (24 + 2,5 mm)



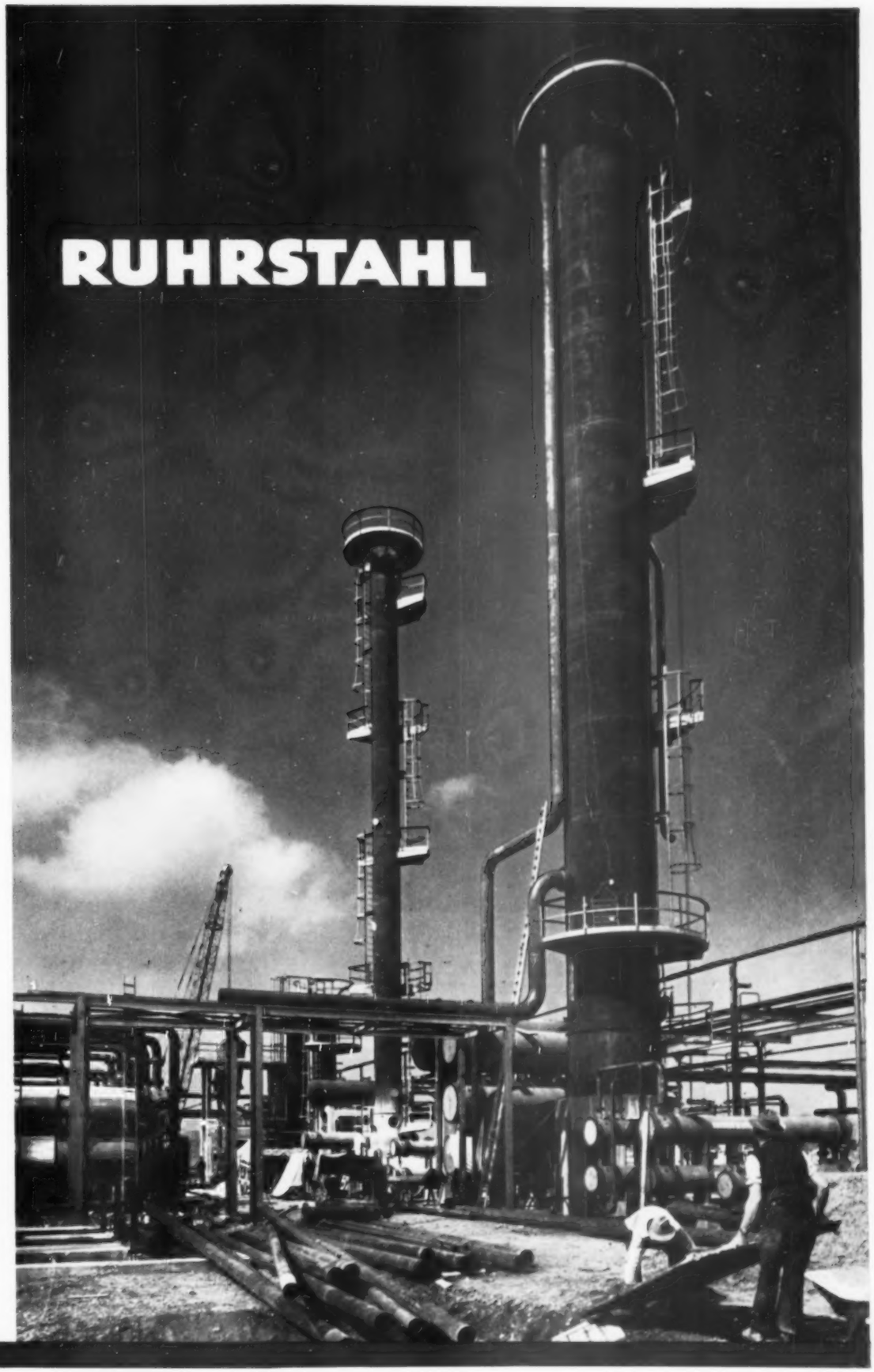
RUHRSTAHL AKTIENGESELLSCHAFT · HATTINGEN/RUHR · GERMANY



Ruhrstahl Heat Exchanger
in an oil refinery.

Feed Product Exchanger
(3 elements) and
Stripper Reboiler according to
Lummus design, for an oil refinery.
Complete weight:
feed product exchanger
18,610 lbs. each
stripper reboiler 8,710 lbs.
Heat exchanging surface:
feed product exchanger
2830 sq. ft. each
stripper reboiler 873 sq. ft.

RUHRSTAHL AKTIENGESELLSCHAFT · HATTINGEN/RUHR · GERMANY



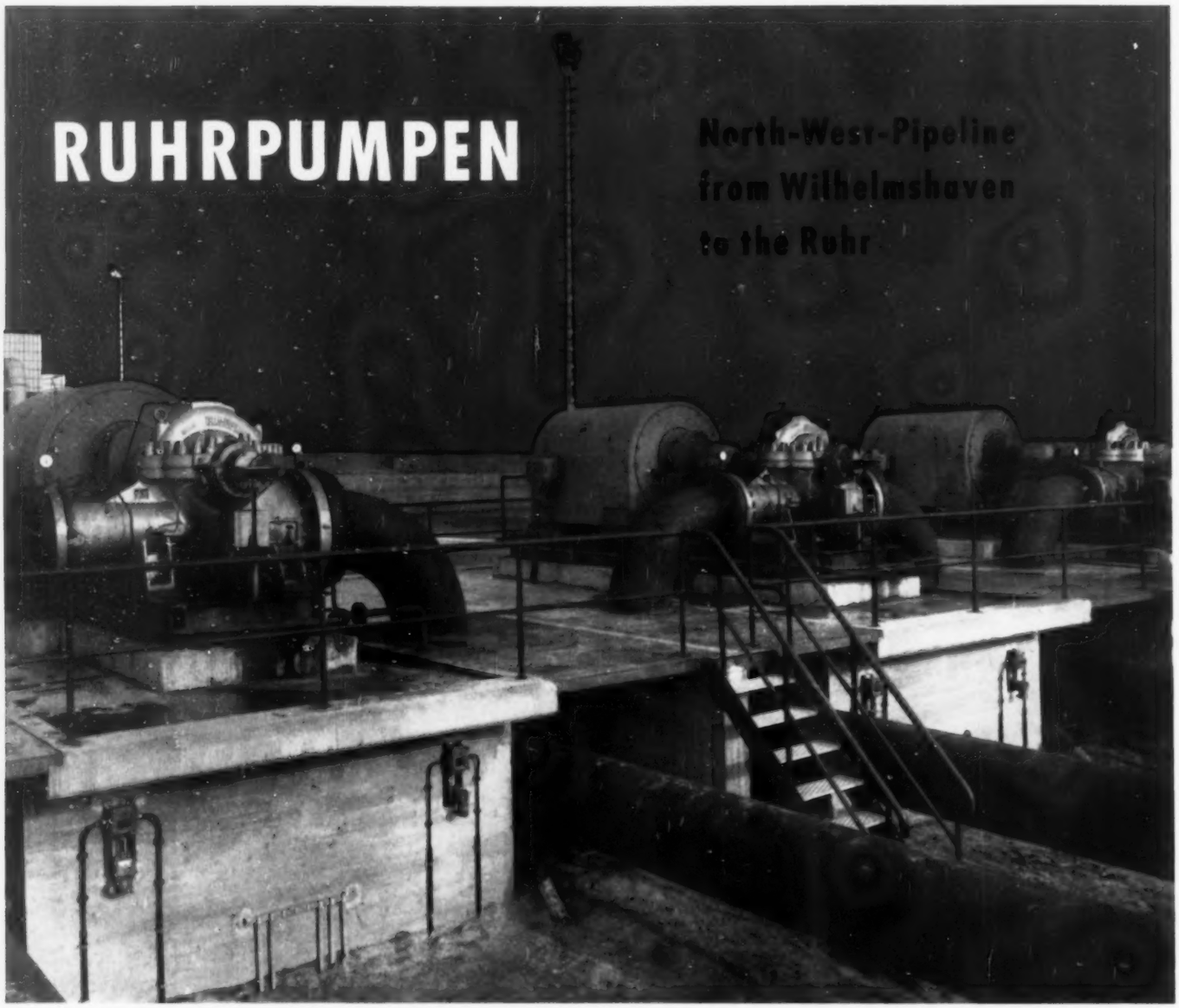
Erection of a Feed-Splitter-Column (foreground) and a Stabilizer-Column (background) for an oil refinery in Western Germany.

Technical data:
Feed-Splitter-Column:
outs. dia.: 8' 6"
length: 84'
weight: 72,765 lbs.
material: boiler plate H II
thickness: shell 15/32"
upper head 1/2"
lower head 19/32"

Stabilizer-Column:
outs. dia.: 4' 1"
length: 83'
weight: 35,280 lbs.
material: boiler plate H II
thickness: shell and
upper head 15/32"
lower head 19/32"

RUHRSTAHL AG · PRESSWERKE BRACKWEDE · BRACKWEDE · GERMANY

RUHRPUMPEN



The first stage of completion provides an initial capacity of the pumps delivered by Ruhrpumpen GmbH. of 7500 U. S. gpm at a discharge pressure of 1000 psi. The power required for each pump amounts to 2000 h. p. The installed pumps have been designed with regard to their principal elements in such a manner that they will reach a final capacity of 15400 U. S. gpm at a discharge pressure of 1400 psi. only by changing their impellers and making use of a. c. driving motors rated for more than 3000 h. p.

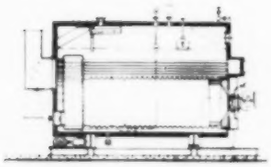
FOR THE OILINDUSTRY

We supply **petroleum refineries, natural gasoline plants, petrochemical plants and similar installations**
with **pipeline pumps and pumps to provide efficient and dependable continuous process service**

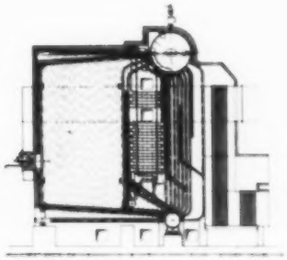
RUHRPUMPEN GMBH · WITTEN-ANNEN · GERMANY

4 Hits

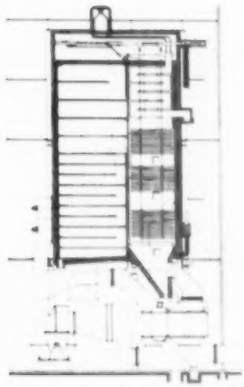
IN STEAM GENERATOR DESIGNING



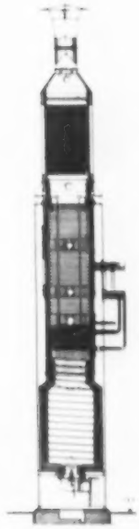
1 t/h – 10 t/h, 20 atm, 300° C



5 t/h – 25 t/h, 42 atm, 475° C



100 t/h, 132 atm, 520° C
Benson-Boiler



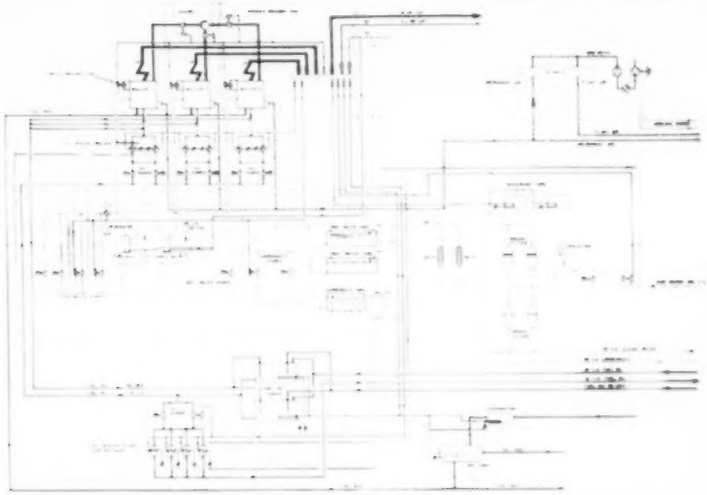
25 – 150 t/h, 200 atm, 520° C
Benson-Boiler

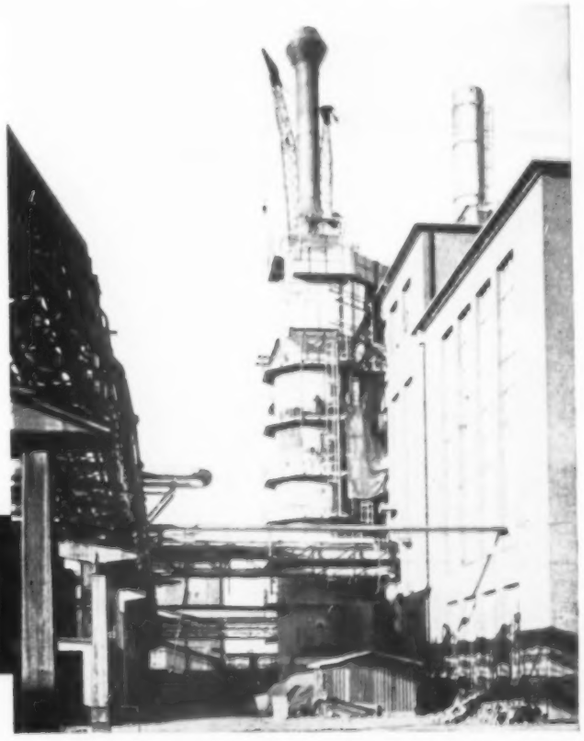
THESE FOUR TYPES OF

WALTHER-BOILERS

COVER THE WHOLE RANGE OF

STEAM REQUIREMENTS IN OIL REFINERIES





WALTHER & CIE. AKTIENGESELLSCHAFT · KÖLN-DELLBRÜCK

7 Furnaces and steam boilers

A-shaped furnace with horizontal tubes. Photo courtesy Friedrich Uhde GmbH, Dortmund

THE heat balance is an important item in the economy of a refinery or petrochemical plant. The descriptions given in the preceding chapter "Process vessels, equipment and tanks" reflect the enormous requirements for steam which is used as a heat source for heating products and process auxiliaries. Many distillation and rectification processes require steam for stripping, fractionating, expelling, fine separation, for heating and for compensating radiation losses. Tank yards and piping for products of high viscosity and high pour point need large quantities of steam, especially in winter, which is admitted to tank heaters and steam tracers to maintain those products at the proper temperature. As far as refineries are concerned, due to the peculiarities of their operations, steam prime movers are the most economical and suitable source of mechanical power to meet the tremendous requirements of a multitude of machines like blowers, pumps, compressors, vacuum equipment, etc. No matter whether the plant is laid out for the production of motor fuels, lubricating oils or fuel oil, any refinery produces a certain quantity of non-marketable by-products such as fuel gas and heavy residues which are utilized most economically on the spot to meet fuel requirements of the refinery. Therefore, the design of the power supply system of a new plant is exclusively guided by the principle of complete utilization of these refinery wastes. It is for this reason that refinery power stations are exclusively equipped with gas-fired or oil-fired steam boilers. Steam-raising capacity of the boilers is selected so that both process steam requirements and electric power requirements of all refinery sections may be satisfied economically by the refinery's own facilities.

The heating of products for process purposes accounts for the largest portion of heat requirements in the refinery. Therefore, the design of heaters is of paramount importance to the overall heat balance of a refinery. As far as fuels are concerned, the same principles apply as those previously discussed for steam generation. The tubular heater with horizontal or vertical tube arrangement is the standard type of refinery furnace. In the radiation- and convection zones of the furnace, the hot flue gas from the combustion of fuel gas or petroleum residues heats the products flowing through the furnace tubes. Many processes in crude oil refineries require temperatures in excess of 500°C (900°F) and the heat duty of these furnaces is always in the range of several million calories. Various furnace designs are available to suit operating conditions and product characteristics. Particular attention must be devoted to the furnace tubing where designers are faced with numerous problems such as velocity and residence time of the products inside the tubes, materials to be used and access to the interior of the tubing, all of which need a solution with due regard to pressure and temperature conditions imposed by the process. The following brief enumeration according to use of the types of furnaces gives only an approximate idea of the great variety of problems encountered in the field of furnace design.

Group of "Ekatherm" furnaces with vertical tubes. Photo courtesy Ernst Kirchner, Hamburg 1

Tubular Furnaces with horizontal or vertical tubes, for crude oil, heavy gasoline, gas oil, lubricating oil, heavy oil and other fractions.

Reforming Furnaces, for thermal and catalytic reforming processes.

Cracking Furnaces, for thermal and catalytic cracking processes.

Visbreakers, Cokers, for heavy oils and asphalts.

Dehydrogenation Furnaces, for the production of olefines.

Splitters, for the thermal and catalytic splitting of industrial gases, such as natural gas, ethane, propane, butane, etc. for the production of synthesis gas for chemical and petrochemical purposes.

Special furnaces for the gasification of oil.

Reactors, Quench type reactors and Regenerators.

U-tube preheaters.

Special preheaters and evaporators.

Thermal conditions of the process, type of tubing and suitable design of the burner chamber are factors which influence the outward shape of the refinery furnaces in each application. Among the most common shapes of tubular furnaces are: vertical furnaces, horizontal furnaces, box type furnaces, A-frame furnaces. The mechanical design of the furnace is largely dependent on the fuel to be used. This decision determines the type of the burners which, in turn, fixes the shape of the combustion chamber.

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H_2S Boiler with Burner for the CLAUS REACTION

$H_2S + \frac{1}{2} O_2 = S_{rh} + H_2O + 52{,}95$ Kcal/g-mol

Input Pressure—14 atm. gauge

Operating Pressure—12 atm gauge

Steam generated—2460 Kg/h saturated steam

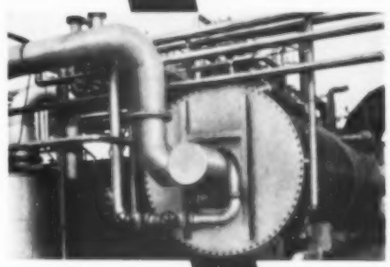
Quantity of H_2S, 750 m^3/h

Exit temperature of Flue Gas 300° C

Boiler Plants for Refinery Excess Gas

Inlet pressure	21 atm. gauge
Operating pressure	19 atm gauge
Super-heat temperature	240° C
Steam delivery	11,000 Kg/h
Hot gas delivery	1,000 Kg/h
Hu	11,180 Kcal/Kg
Snuffle gas	1,055 Nm^3/h
Hu	179 Kcal/Nm^3

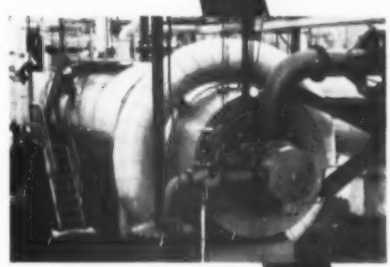
Exit temperature of Flue Gas 440° C



Boiler Plant for Producing Steam and for Obtaining CO_2 by Burning with Oxygen

Inlet Pressure	7 atm gauge
Operating Pressure	6 atm gauge
Superheating temperature	200° C.
Steam Delivery	4,450 Kg/h
Fuel, CH_4—gas—methane	

With this plant we have obtained a 95% CO_2 gas. The plant can be converted to produce steam and for obtaining $CO_2 + N_2$ by combustion with air.



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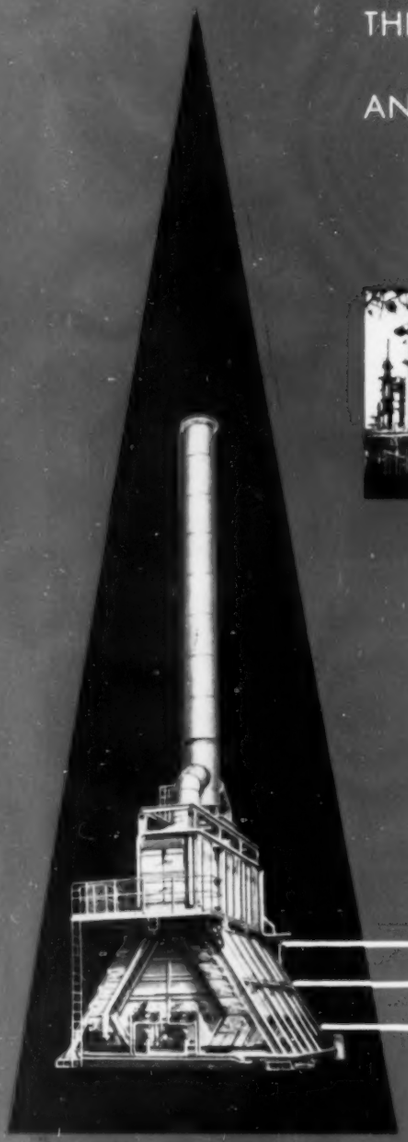

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the chemical industry and the
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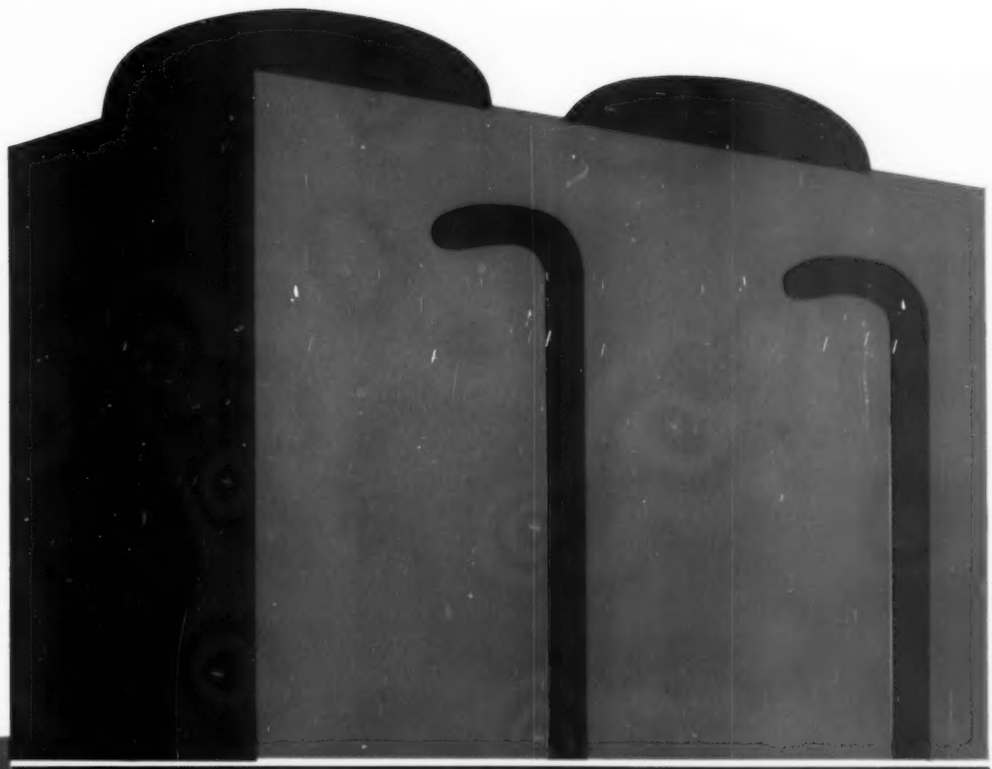

ERNST KIRCHNER HAMBURG 1

Pipestills for Mineral Oils
and
Equipment for Indirect Heating
by Diphyl, HT-Oils and other
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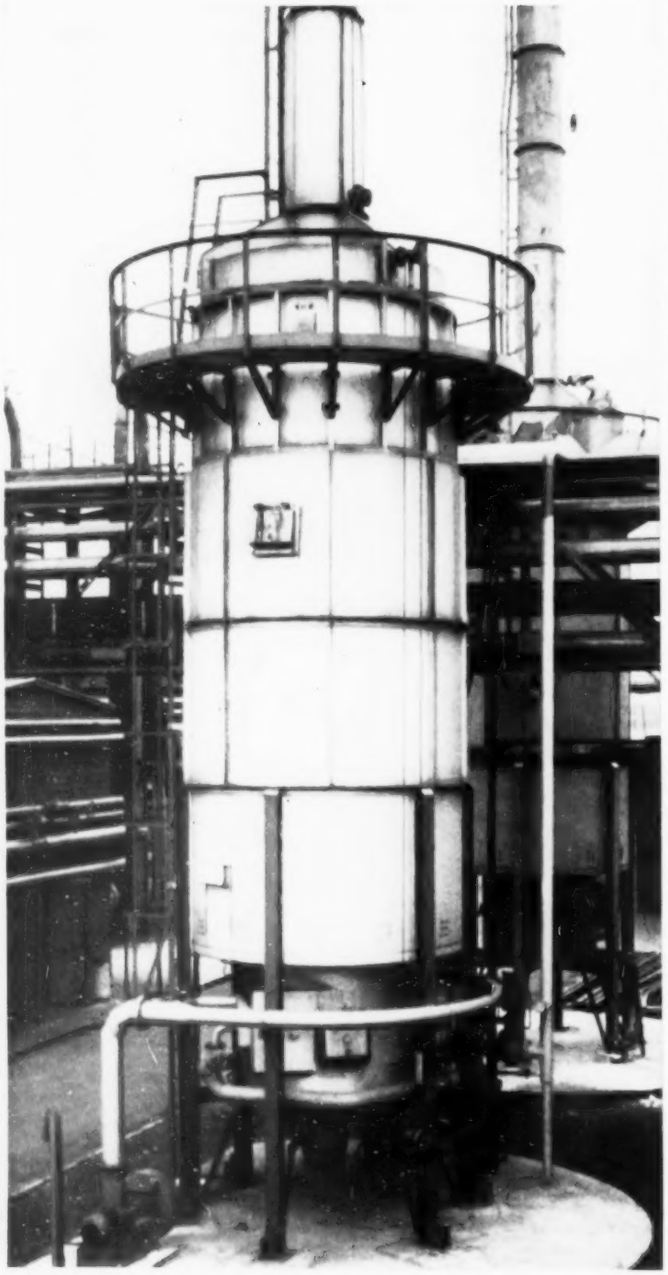
System Delcker-Neuburg



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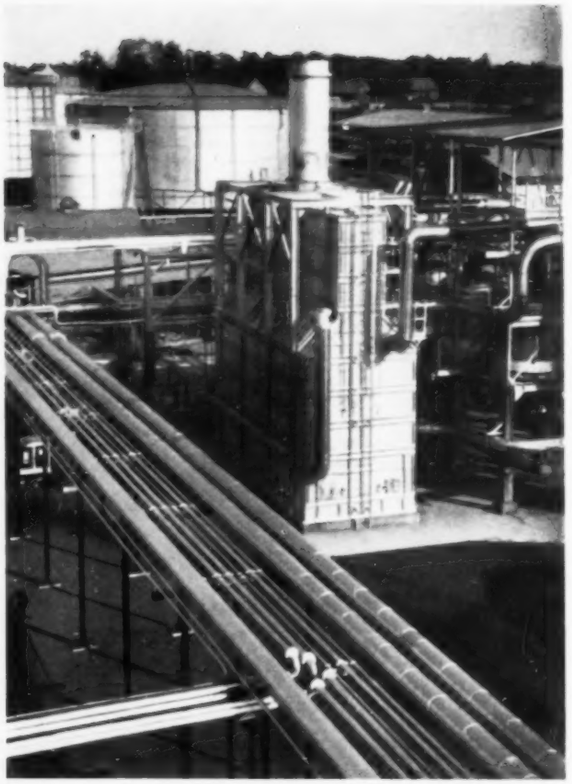


Furnace with horizontal tubes. Photo courtesy Ernst Kirchner, Hamburg 1

In many processes requiring high temperatures, complete waste recovery is imperative in order to obtain an economic refinery heat balance. Therefore, due consideration should be given in the planning stage to the thermal engineering design including the installation of waste heat boilers in order to achieve a high overall thermal efficiency.

As mentioned before, refinery wastes such as fuel gas, residues from cracking operations, heavy residues, asphalts and pitch are obtained as by-products in any crude oil process, and designers of modern refineries are faced with the problem to utilize these waste products as fuel for furnaces and boilers. In the design of furnaces and steam boilers, consideration must be given to the particular characteristics of both the heavy and the light residues. The "fuel" is obtained in the liquid phase as well as in the gas phase. Liquid phase fuel passes to the stock tank at a temperature of about 200°C (400°F) while the light residues—middle oil, light oil or even liquid gas—reach the tank at ambient temperature. In view of the fact that these products are obtained in variable quantities and, in the case of heavy residue, with a variable viscosity, special provisions must be made for the control of the burners and for compensating such fluctuations. The variable operating condition in a refinery require great flexibility of the burner facilities and safe provisions for a speedy change from one fuel to the other without any appreciable disturbance or even interruption of thermal processes.

While operating safety can be improved in steam generating plants by dividing the total steam-raising capacity between several units, this practice cannot, in general, be followed in the case of heaters unless investment costs are allowed to exceed any reasonable level that can be afforded by the refinery. To safeguard a reliable operation and an economic utilization of fuel, the following requirements must always be satisfied in the design of heaters and steam boilers:

1) Pre-treatment of heavy residues to ensure a satisfactory combustion independent of fuel characteristics.

2) Provision for a rapid change from one fuel to any other fuel or combination of fuels.

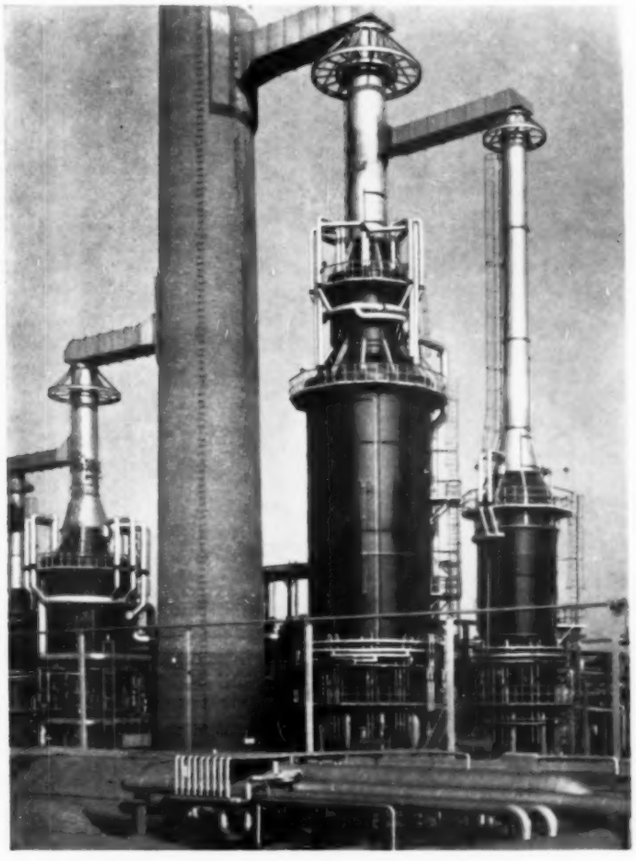
The viscosity of heavy residues is very high and elevated pour points of 100°C (212°F) and more must always be expected. However, the viscosity needed to ensure a satisfactory atomization requires a temperature of about 180°C (360°F). The characteristic curve of the viscosity is generally very steep in the temperature

range from 100 to 180 C (212 to 360 F). Therefore, even a slight temperature drop in pipes, valves and fittings is sufficient to cause a substantial increase in viscosity which may lead to plugging of the system or to flame failure. This means an inevitable expenditure to be spent on the heating of fuel supply piping to the burners. High-pressure steam which can be produced in the same facilities is generally used as heating medium to maintain fuel temperature at about 200 C (390 F). On the other hand, fuel oil temperature may be too high. In this case, the stock tank must be cooled. Cooling facilities used for this purpose are designed so that high-pressure steam can be admitted at any time to prevent "freezing" of the fuel oil during change-over or shut-down periods.

The change from fuel oil to fuel gas involves particular requirements to be satisfied by the automatic shut off and control valves with regard to a safe and positive seal. Gas may be burned alone or in a combination with heavy or light residues. Special control links are provided to safeguard a correct proportioning of combustion air and fuel for different ranges of throughput and variable ratios of combination oil/gas fuel. The calorific value of the fuel varies with the composition of the residues. It is good practice to supply the burners with a certain amount of excess air so that the smoke limit may not be reached even with rising calorific value of the fuel. For furnaces, the principle of outdoor installation has always been followed. In the case of steam boiler plants, outdoor installation is a relatively new trend which has developed after the conventional ideas related to the coal-fired power station were abandoned. Modern oil- and gas-fired steam boilers are entirely suitable for outdoor service. These steam boilers including superheaters, preheaters and economizers practically require no attendance. The front wall of the boiler setting and the instrument platform usually extend into a closed building which also houses the oil pumps, feed water treating facilities, feed water pumps and gas pressure reducer.

Finally, it should be mentioned that a certain positive pressure is maintained in the boiler furnace and that the flue gas is forced along the heating surfaces to the steel stack by the pressure of the combustion air. The exterior sheet steel covering of the boiler setting is, of course, gastight and provides sufficient weatherproofing for boilers in outdoor service.

Group of "Petrochem" furnaces with vertical tubes. Photo courtesy Friedrich Uhde GmbH, Dortmund



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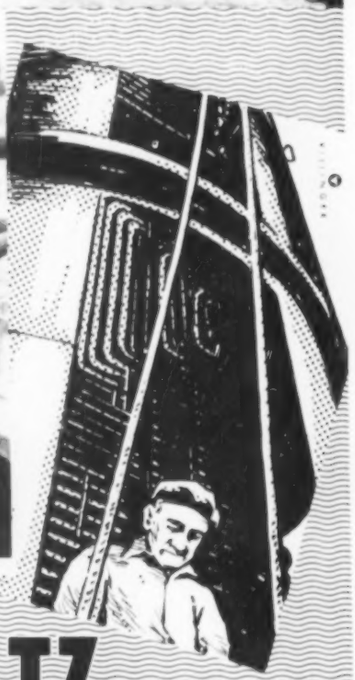

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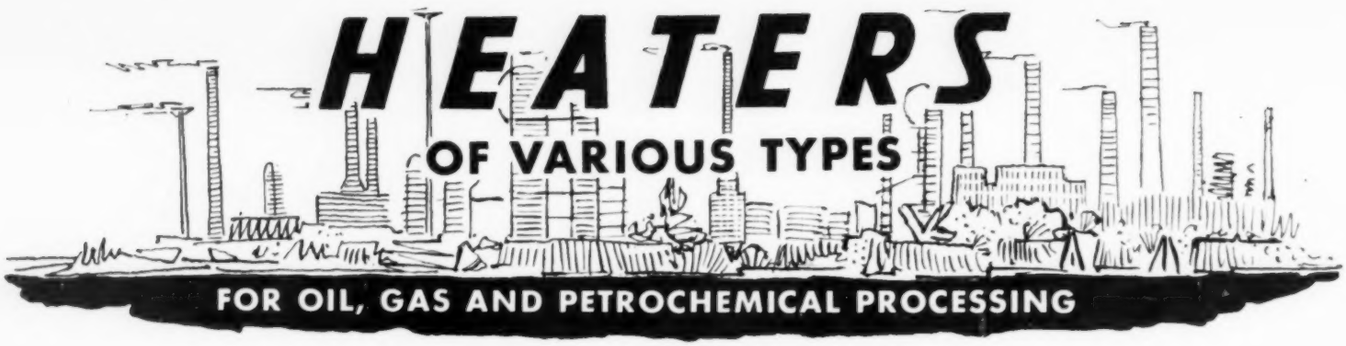

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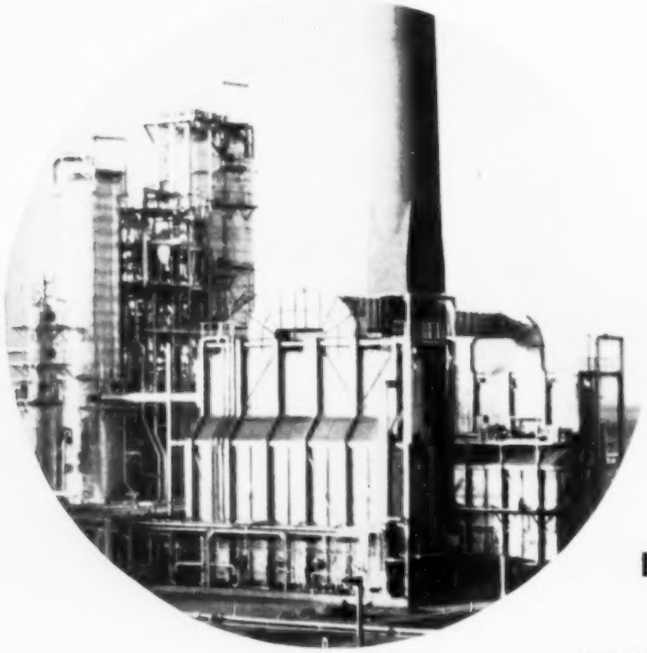

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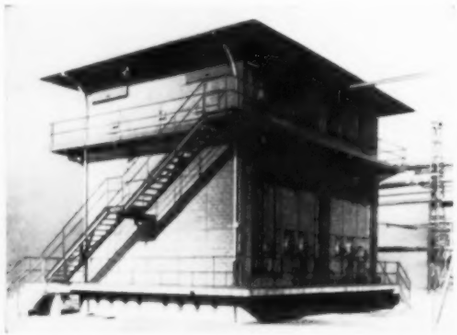

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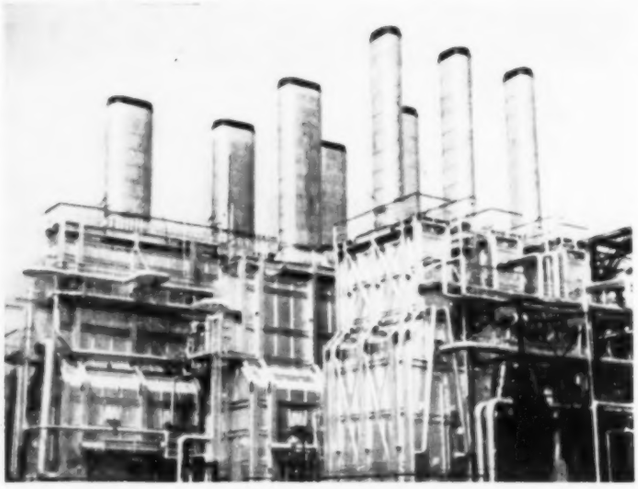

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reinforcements,
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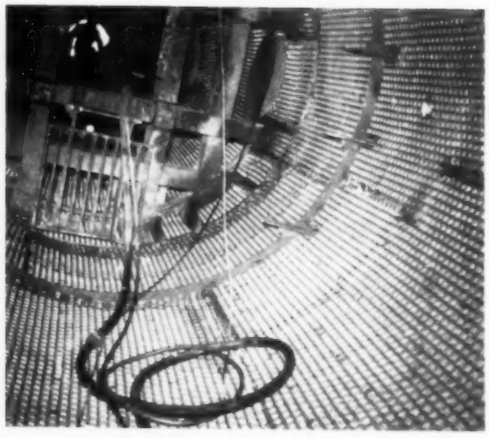

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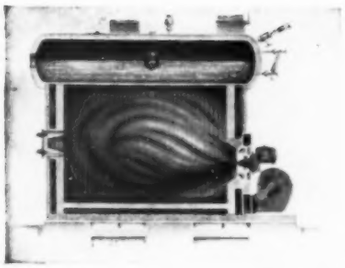

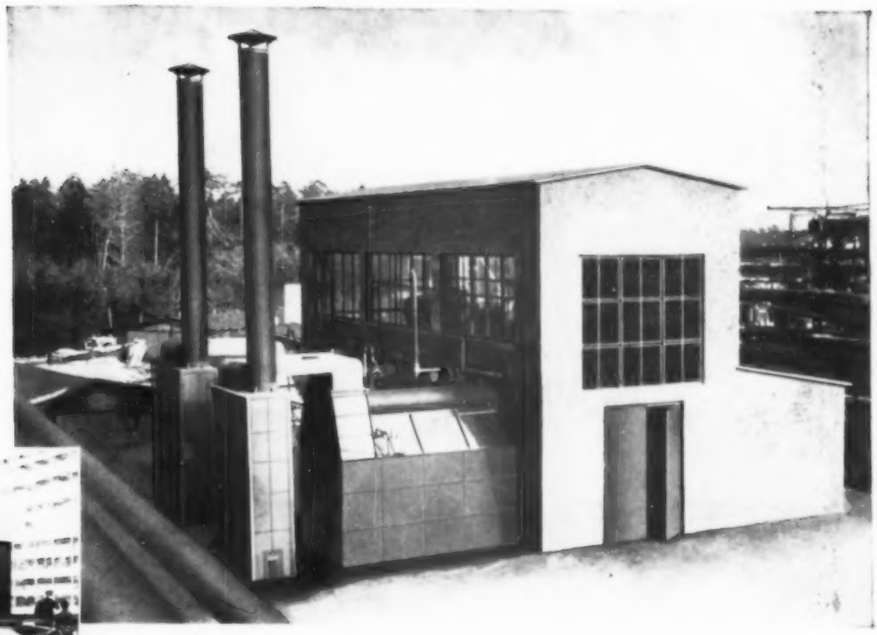

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An example from our practice:

A big concern of the German chemical industry uses one firing system for the combustion of five different fuels:

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2. *heavy remainders of refining*
3. *residue gases*
4. *combined light fuel oil — residue gases*
5. *combined heavy remainders — residue gases.*

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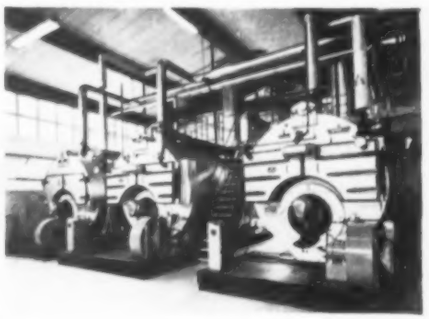

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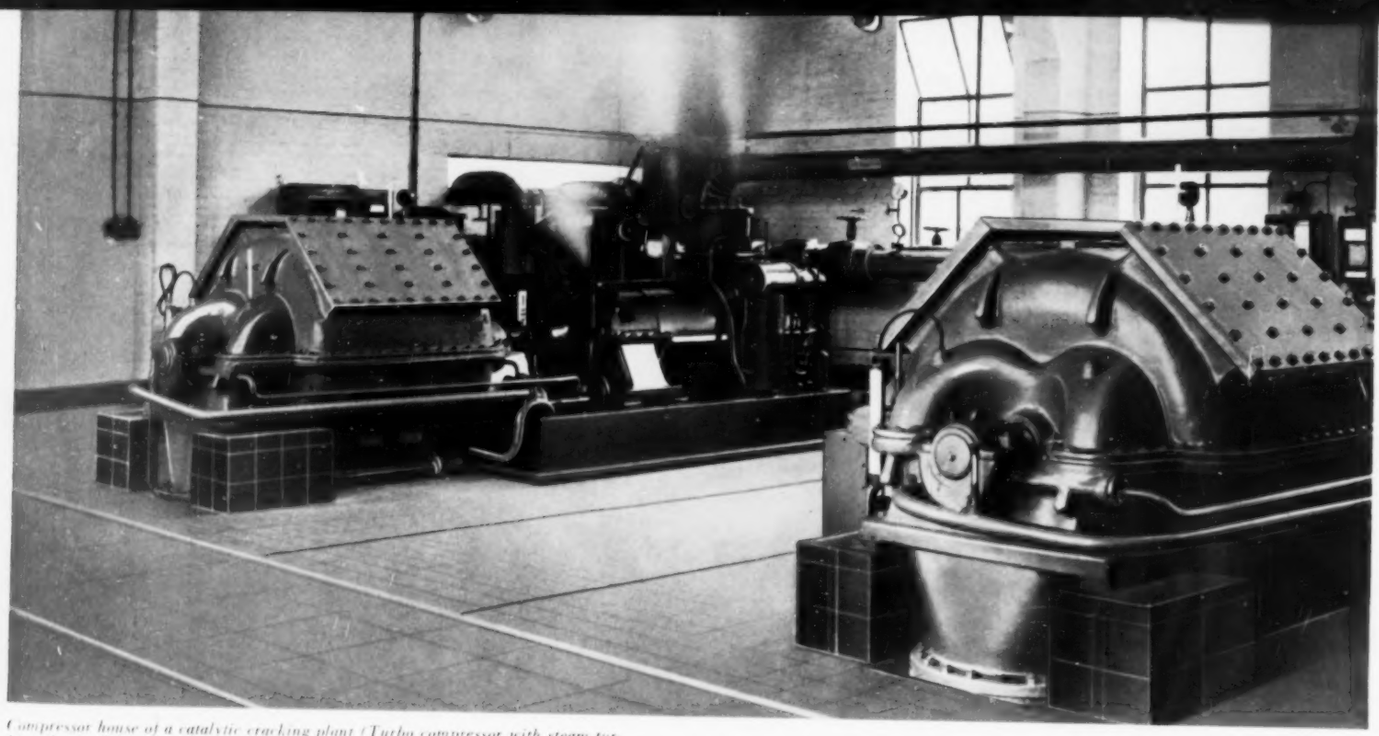


Compressor house of a catalytic cracking plant (Turbo compressor with steam turbine drive). Photo courtesy Friedrich Uhde GmbH, Dortmund

8 Prime movers, compressors, blowers, pumps and auxiliaries

THE correct selection of prime movers and the machines themselves constitutes an important item in the planning of a refinery. In the preceding chapter reference was made to the special problems of energy economy in refineries. It is essential for each refinery, and also for most petrochemical plants, to utilize rest gases and residues which are unavoidably produced for energy purposes.

As far as these byproducts are used as heating media, they are directly fired in furnaces for the heating of various products or for the generation of steam. As far as possible, the utilization of high-grade fuels for these purposes is avoided. Probably the only exception is the use of diesel oil and gasoline as motor fuel for emergency power units which constitute an essential part of each refinery. These emergency power units are required in case of power failure to supply the necessary energy for shutting down the refinery in a proper way, and for the supply of power and light to safety devices such as fire-fighting equipment, instrument rooms, and signalling systems. In view of the fact that as far as quality and quantity are concerned the vent gases vary a good deal, they are seldom used directly in gas turbines. The generated steam is utilized for driving generators, for the supply of electric current, and to take care of the numerous small power consumers such as pumps, blowers etc. Since the steam requirement for heating purposes in those plants is usually quite large, steam is often used for a better energy economy for driving large-size pumps and compressors. As such steam turbines in comparison with the customary steam turbines in power plants are of smaller capacity, a special branch of the industry developed in Germany for the manufacture of such individual drives can now offer a multitude of modern and economic small driving units. This economic type of steam turbine has practically completely displaced gas engines and piston steam engines. As far as the latter are concerned, only Simplex and Duplex pumps for the direct drive of piston pumps are still used. These piston steam engines are applied in particular as prime mover for pumps with a high discharge pressure or for pumps of very small capacity. Furthermore, such steam-driven piston pumps are still used a good deal in oil fields and in tank yards in case the exhaust steam is simultaneously used for the heating of tanks, pipelines, and plant parts. In this way, an additional investment in cables for the supply of electric energy can be saved. So far as high-pressure steam is available inside the plant area, prime movers in the form of steam turbines are always preferred in view of their higher thermal and mechanical efficiency.

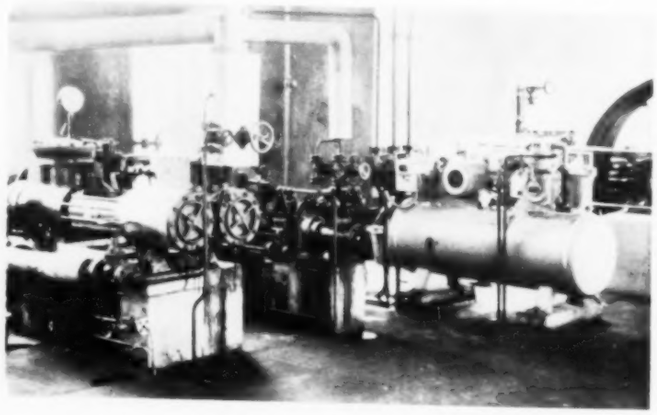
In Chapter 12, electric motors as prime movers are dealt with in detail. In that chapter also the special protective measures for the use of electric prime movers and equipment in refineries are discussed.

Couplings, toothed-wheel gearings, hydraulic drives, belt drives, and V-belt drives are used for the connection between the prime mover and the machine. It is essential that all driving elements used in refinery operations meet requirements for the greatest possible protection against explosion and that they are absolutely nonsparking.

Particularly important is that proper grounding of all moving machines and parts is provided to insure that stray currents and generation of static and dynamic electricity are avoided completely.

The construction of the modern steam turbines with their pressures of from 50 to 200 atm. g. (750 to 3000 psig.) and temperatures above 300° C up to 600° C (570 to 1110° F) involves difficult problems for manufacturers and their engineers. Furthermore, these steam turbines now must be constructed for capacities from 100 to 600 million watts. All of this means that a number of construction problems had to be solved. The impetuous development of process technology and energy generation call not only for the smallest size steam turbines for individual drives, but also for construction of large-size turbines for power plants. Consequently, the engineer is

Reciprocating pumps of a crude oil desalting plant (steam driven). Photo courtesy Friedrich Uhde GmbH, Dortmund



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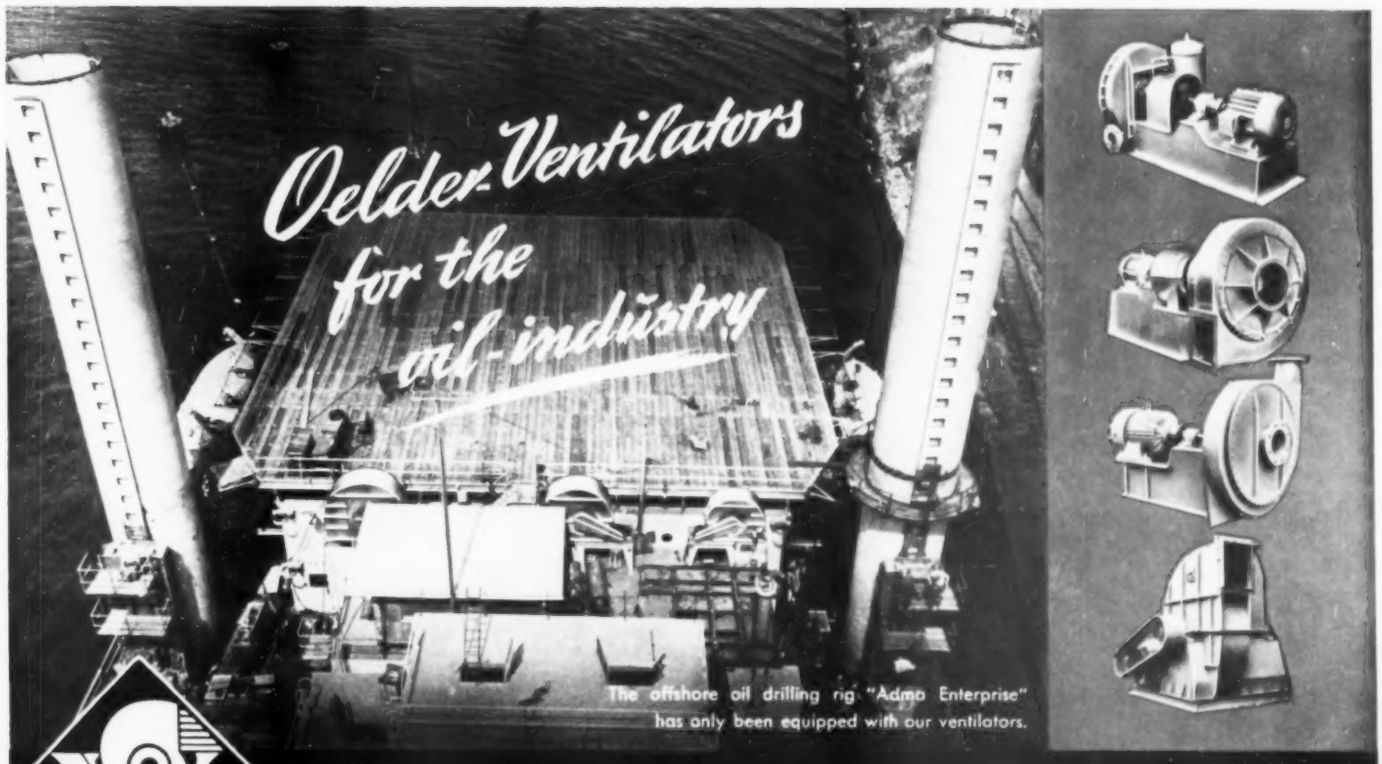

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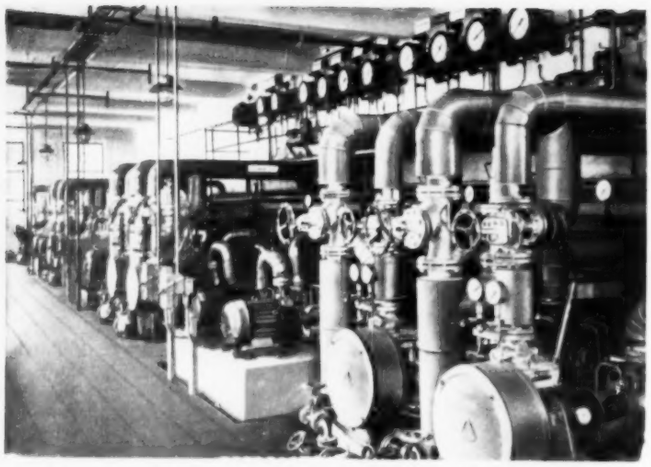


Pump house of a catalytic cracking plant (with electric and steam drive). Photo courtsey Friedrich Uhde GmbH, Dortmund

constantly faced with new construction problems calling for new developments; while, on the other hand, the customer insists on having the manufacturer standardize his products as much as possible. Such standardization makes rational production possible and reduces the investment cost of plants and factories to an economical extent. The purpose of standardization is not only to simplify manufacture, but also to build larger size units by simply assembling smaller size prefabricated parts.

Although this tendency for standardization may now be considered as a basic requirement for each type of manufacture, application of this standardization to the construction of such special high-capacity machines may be especially emphasized.

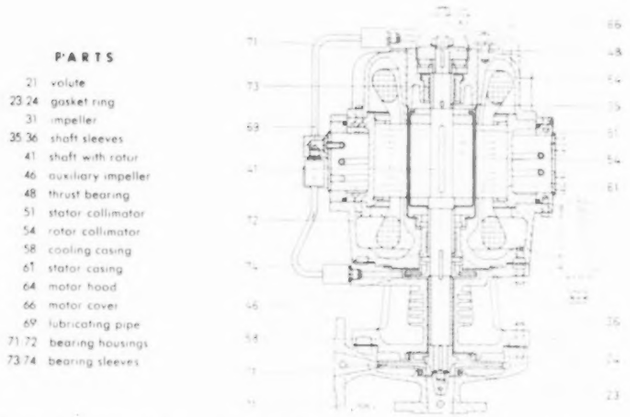
In the field of pump construction, the same development with regard to standardization took place about ten years earlier. The rationalization took place especially with regard to process pumps, which in particular in the petroleum industry and also in chemical plants in general the standardized types could be used to a large extent. As a result, practically every pump manufacturer now can offer a number of single and multiple stage pumps in standard construction. As a consequence, the stock of spare pump parts in refineries is now only a fraction of what it used to be.

Bearing blocks, shafts, bearings, stuffing boxes, shaft sleeves, etc., as well as used materials are so standardized that the same parts can now be used for 15 or 20 pumps of different size. Today types of pumps without stuffing boxes are more and more used as process pumps; in this type, the pump impeller and the rotor of the motor are placed on a common shaft. Since motor, rotor, and stator are separated from the medium by means of a welded-on plate, a completely closed standard construction of the casings could be developed. Also standard types of pumps without stuffing box with permanent magnetic couplings are manufactured, in this case moto and pump have separate casings. Over and above these types, a number of pumps without stuffing box are now obtainable such as diaphragm pumps, geared pumps, eccentric shaft pumps etc., which normally are only used in very small sizes for operation in laboratories and pilot plants.

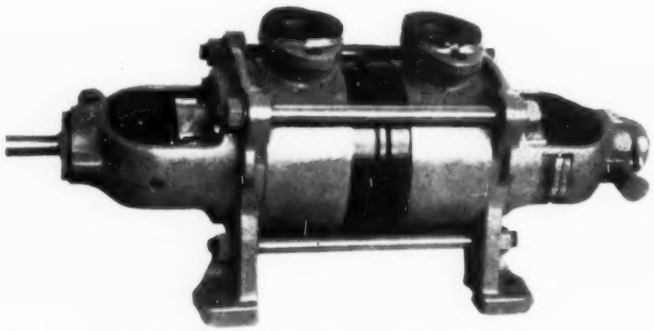
Vertical, self-priming centrifugal pumps which are available in many different sizes without stuffing box are also used a good deal. This type of centrifugal pump in vertical or horizontal construction has practically replaced the nonself-priming centrifugal pumps. The field of application of these self-priming centrifugal pumps is extensive, since they can be used for the transfer of liquefied gas for many industrial purposes up to and including the transfer of motor fuels in tank yards.

This wide field of application became largely possible because these pumps can be made of many different materials, including corrosionproof alloyed steels and plastic materials. Due to the fact that the self-priming centrifugal pumps do not get vapor-bound, they are particularly suited for the transfer of volatile liquids such as gasoline and kerosine, and liquefied gas such as propane and butane. The broad manufacturing program of the German pump manufacturers offers all possibilities of application in the petroleum and chemical industries and all different kinds of processes.

The broadness of their program guarantees that the most suitable pump construction can be supplied for each individual case regardless of whether the service requirement calls for transferring process water of normal temperature, or liquids of very high temperatures, or motor fuels, or highly concentrated acids.

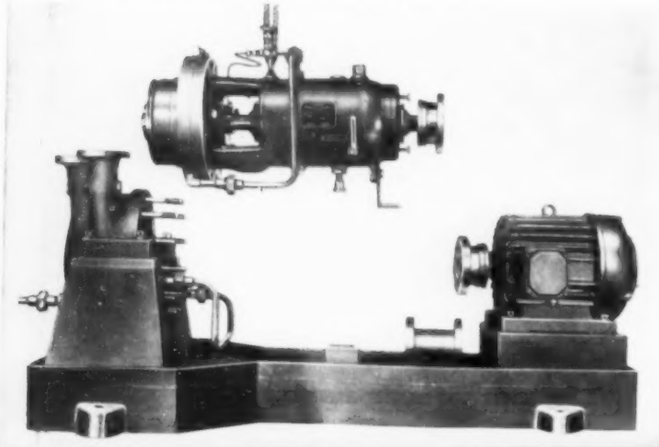


Vertical centrifugal pump without stuffing box courtesy KSB, Frankenthal



Pump for LPG. Courtesy Sihi-Pumpen, Itzehoe Holstein

Standard type process pump. Photo courtesy KSB, Frankenthal



Aside from the pumps mentioned above, the German manufacturers can also supply helical pumps, pumps with inclined rotor, rotary pumps, geared pumps, etc. In the field of vacuum pumps, a few special types should be mentioned, such as Elmo pumps, Root pumps, and pump sets which combine the various pumping systems in an effective way.

Reciprocating pumps are applied for service of pressure pumps for very high pressures and also, to a large extent, as proportioning pumps.

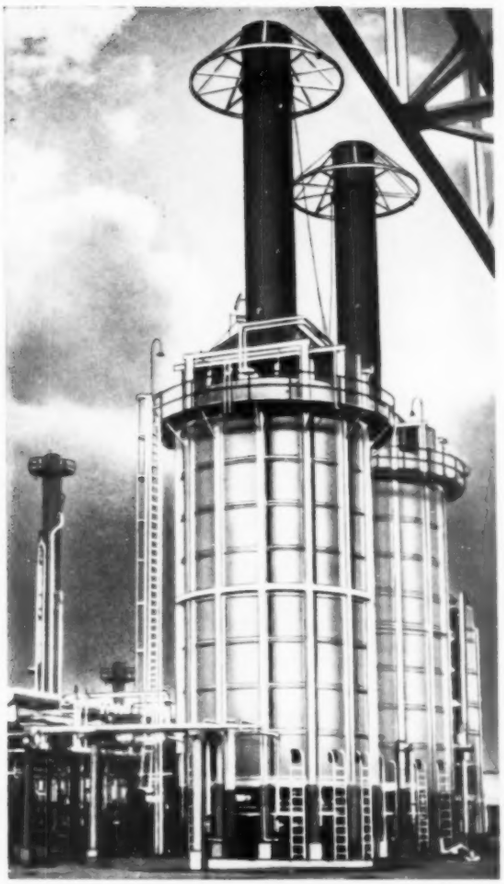
The easy adjustability of these pumps does in no way unfavorably affect proportioning accuracy and operating reliability. Long before the turn of the century a broad German compressor construction program was established, and extended and modified with the requirements of the chemical and oil industries.

In solving the various problems in connection with this develop-

MÜLLER SCHUSS

SYSTEM STRUTHERS WELLS CORPORATION, WARREN, PA., USA

FIRED HEATERS



Two Struthers Wells oil heaters capacity 54 000 000 BTU/h each, installed in a new refinery

TYPICAL SERVICES

Gasoline reforming • crude distillation
Heavy fuel processing • circulating heating
cracking hydrocarbon liquids and gases
Rich oil heating • heating asphalt
Heating petroleum oils
Steam superheating • heating organic fluids
and other services

STRUTHERS WELLS HEATERS

are supplied in several standard types, also in special designs as required for unusual services.

Sound thermal and mechanical design and good construction insure high efficiency and long life with minimum maintenance charges.

A fired heater is made up of two sections:

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The convection section installed above the radiant section consists of a bank of horizontal fin tubes.

Heater coils can be delivered in any commercial alloy.

Units are in service at temperatures above 1700°F.

Most heaters may be shipped completely shop assembled. About 600 of these units have been constructed.

FEATURES OF DESIGN INCLUDE:

Adequate combustion space for complete combustion without excessive air, allowing maximum fuel efficiency.

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Low furnace setting losses.

Insulating refractory is used with low heat capacity.

Tight furnace construction, with air leakage substantially zero.

Panel type of construction is used for the larger size heaters, with panels quickly removable for complete access to the tube bundle.

The heater is completely weatherproofed for outdoor installation in any weather.

A compact design allows quick field erection. Practically all of the refractory may be installed before shipment to the field.

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Distillation equipment
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1. Qur heaters have proven their merits in the oil fields and for heating of tanks and tank cars
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   DEA
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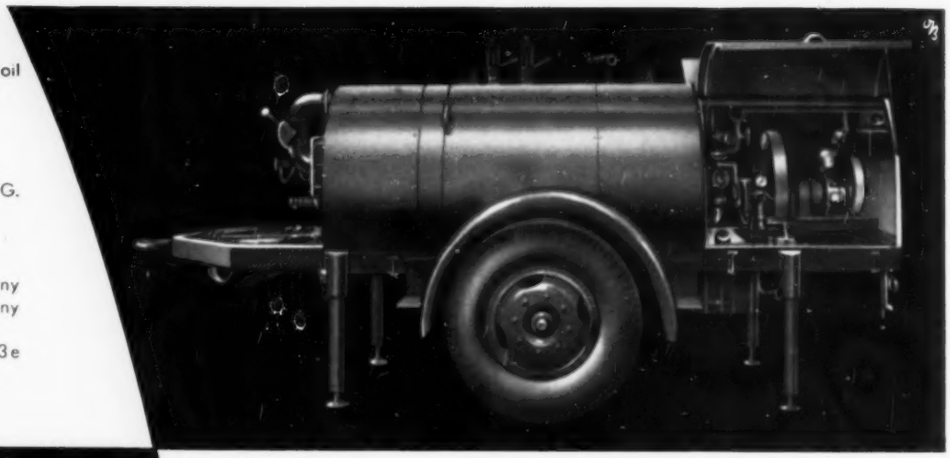
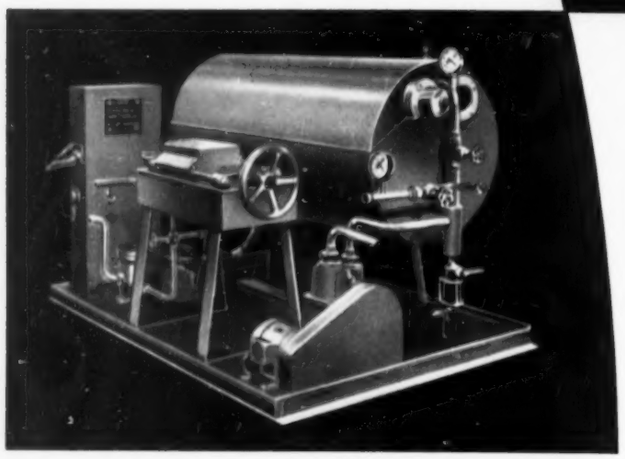
   Mosul Oil Fields Company
3. Please ask for copies of our Publication A 5 1243 e and of our pamphlet „Tank car heater".





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2. Degassing 3. Drying 4. Treatment
5. With hourly capacities from 50 to 2100 US gallons/h
6. Each refinery can provide their customers with 60 kV transformer oil in irreproachable condition.
7. Best references from European and overseas companies.

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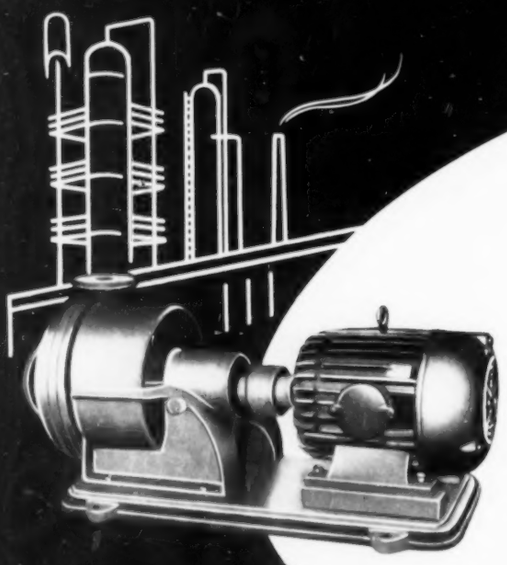

CENTRIFUGAL PUMPS
of acid proof material and without stuffing box

GLOBE VALVES & SAFETY VALVES

BACK PRESSURE VALVES & GATE VALVES
in straight and angle construction
of acid proof material and without stuffing box

EQUIPMENT MANUFACTURE
throttle valves, sight glasses,
liquid level indicators, dirt catchers

F. KLAUS BOCHUM

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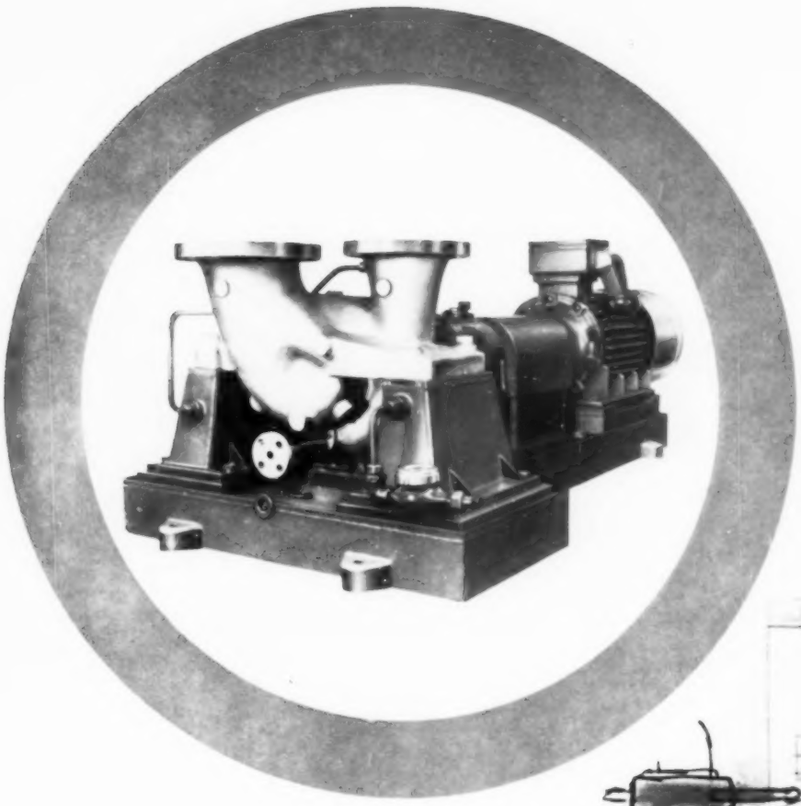

Pumps for:

- *I.C. Engine Fuels*
- *Crude Oil*
- *Gas Oil*
- *Fuel Oil*
- *Lubricating Oil*
- *Liquified Gases*
- *Bitumen*

Valves for:

- *Refinery Products*
- *Water*
- *Steam*
- *Gases*

Compressors for:

- *Air*
- *Gases*

S 0440 - 71

Any Fluid Handling Problems

which may be encountered in the many processes and processing stages of modern refinery techniques, can be solved with products of the KSB-AMAG group of companies. Along with pumps of nearly all types designed for the various duties in the mineral oil and processing industries, our lines also include compressors and valves.
KSB-AMAG products embody the latest stages in technical development, as they have been conceived in close cooperation of scientists and engineers, and a continuous exchange of ideas with users.

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AMAG

KSB Export GmbH, Frankenthal/Pfalz - Germany

HALBERG

supplies the petroleum and chemical industries with proven designs of centrifugal pumps and compressors

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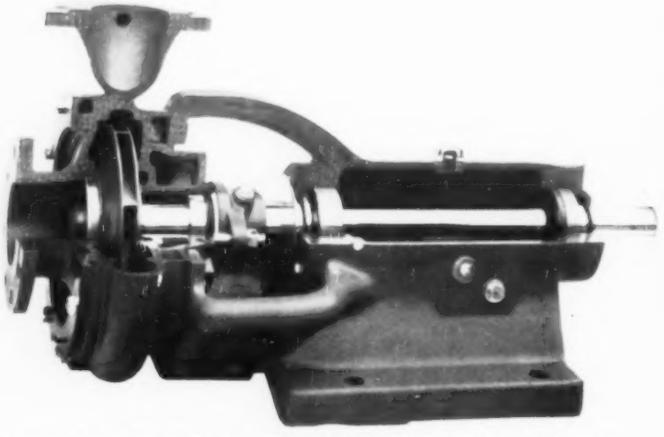
HALBERG

MASCHINENBAU UND GIESSEREI GMBH
LUDWIGSHAFEN/RHEIN

Vertical pump set. Photo courtesy Sihi-Pumpen, Itzehoe/Holstein

ment, the construction engineers had to pay particular attention to the necessity of building compressors which could stand up under continuous operation in the chemical plant and to show an absolute reliability in meeting all requirements of these machines called for by the processes in which they were to be used; this conglomerate of requirements was decisive for the type and construction of the compressors.

In this way, the horizontal compressors with one or more stages of proven construction for exceptionally large capacities and for very high pressures were developed during the early years of industrial compressor manufacture. Compressors are used for air fractionating plants; for the compression of oxygen and nitrogen, synthesis gas for ammonia and methanol production, hydrogen for hydrogenation plants; for the liquefaction of gas; for repressuring underground oil deposits; and for many other purposes. In connection with the development of petrochemistry in Germany after the second



Sectional view of a standard-type centrifugal pump. Photo courtesy KSB, Frankenthal

world war, the scope of application of these compressors was appreciably enlarged, so that construction engineers were faced with the problem of meeting entirely new requirements. In the first place, the capacity of the compressors required for the compression of various hydrocarbons and their mixtures was considerably smaller than that of the compressors used in the abovementioned synthesis plants. At the same time, the pressure range was materially reduced; it normally does not go higher than 60 to 70 atm.g. (900 to 1050 psig.). To a large extent, the requirement of obtaining a compressed medium entirely free of oil has become inevitable, and generally this question is combined with the protection of very expensive catalysts.

These special constructions were made possible by developments in the use of pistons and piston rods suitable for dry operation. In

Developed according to the standards of the "American Petroleum Institute" (API) the HALBERG process pumps type MBS are designed to resolve any problem arising in the range of refinery operations. In addition special attention has been paid to the requirements of continuous heavy duty service.

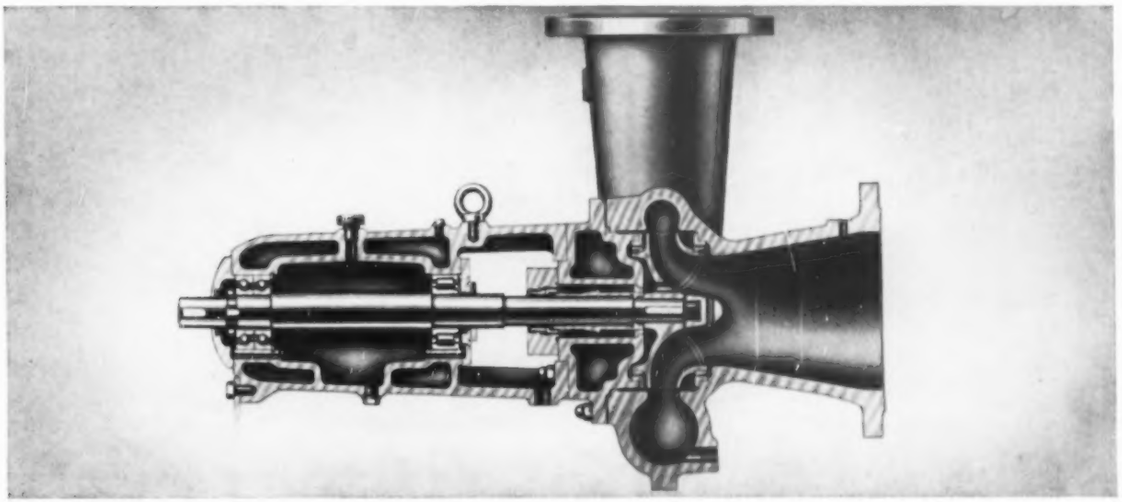
Here are the outstanding features of these pumps:

- sturdy and well designed casings, pedestals and bed plates provide for a smooth operation absorbing possible shocks e.g. caused by solid particles in the pumping liquid
- quick interchangeability of all internal parts
- very low NPSH requirements and high efficiencies are the result of decades of HALBERG experience in the field of hydraulic design

HALBERG

HALBERG pumps type MBS can be used for the high temperatures (about 750° F) arising in petroleum refineries, natural gasoline plants, chemical and other process industries. They are suitable for pumping all liquids ranging from liquid gases to heavy fuel oils and other liquids with higher viscosities (3,500 SSU). Special materials of construction are used for pumps handling abrasive and corrosive liquids. These pumps can also be used for circulating hot water.

HALBERG covers a range up to 3300 GPM and differential heads up to 750 ft. approx. with only 12 sizes of the MBS type. They consist of eight single-stage and four two-stage pumps. Most parts are interchangeable among several sizes, thus reducing spare part stock.



HALBERG pumps type MBS have absolutely stable performance curves. The rise of head from the point of best efficiency to shut off will run from 13 to 20 per cent, so that a satisfactory flow control is possible also in the range of low capacity.

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MASCHINENBAU UND GIESSEREI GMBH · LUDWIGSHAFEN/RH.

Western Germany

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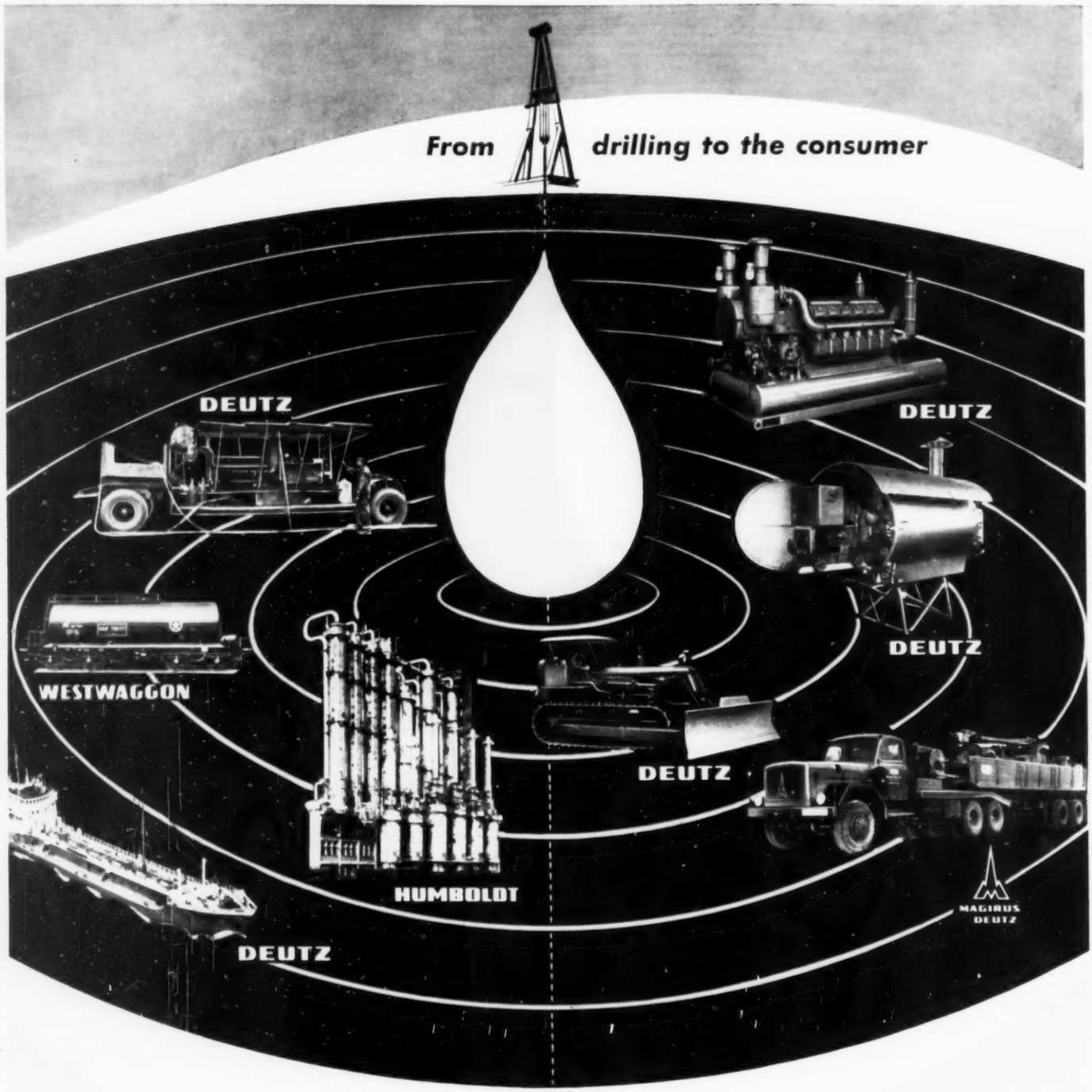

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DEUTZ: Drilling rig engines, stationary and portable power generating units - in particular cathode protection and special pipeline heating units -, crawler tractors, marine engines and auxiliary marine sets for oil tankers.

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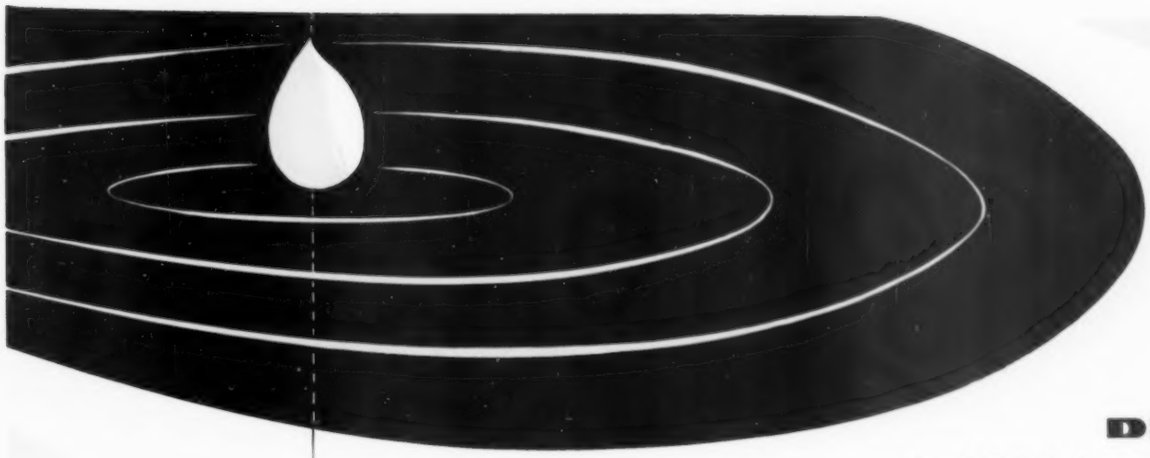

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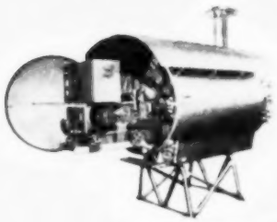

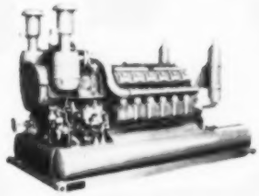

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Air-cooled DEUTZ diesel engines have **given excellent** power service in many oil-fields **throughout the world.** Because of their independence of coolants these prime movers are preferably used **in remote deserts and polar zones.**

Air-cooled **DEUTZ** engined single sets or twin sets of up to **500 HP** are available for drilling rigs.

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DEUTZ air-cooled diesels qualify for these jobs because of their long life and fuel economy.

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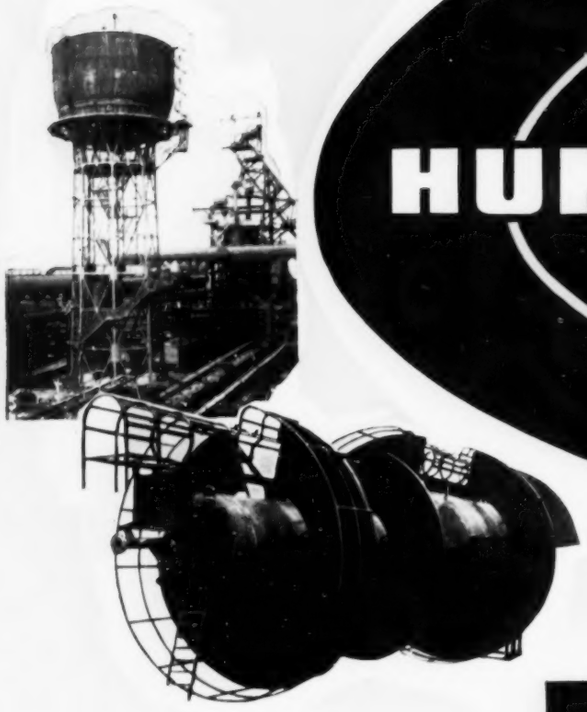

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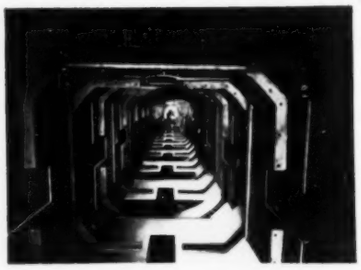

Obliged by their name to research and constant progress the HUMBOLDT works have since their foundation been widely engaged in the field of fuel technology. 100 years ago, particularly installations for the recovery and preparation of coal have been built by Humboldt whereas due to the progress of the energy supply the field of mineral oil processing and oil chemistry has played an ever increasing part in our firm and is obviously still rapidly expanding.

We design and supply complete refining plants according to the process selected by the customers. We advise you as regards all problems of refinery or petrochemical-plant layout and designs and assist you in the selection of the processes suitable for you.

On the basis of modern approved designing and manufacturing methods we design and supply processing units, especially:

. Distilling plants, such as crude oil distilling plants, vaccuum distilling installations, pressure distilling apparatus for "Light Ends Recovery", etc.:

Sweetening and refining plants, such as drying plants for liquid hydrocarbons and gases; installations for gas purification, elimination of hydrogen sulphides and carbon monoxide from refinery gas and liquid gases;

Gas producing plants especially gas producers for special applications on the basis of liquid hydrocarbons and crude oil, production of hydrogen and synthesis gases.

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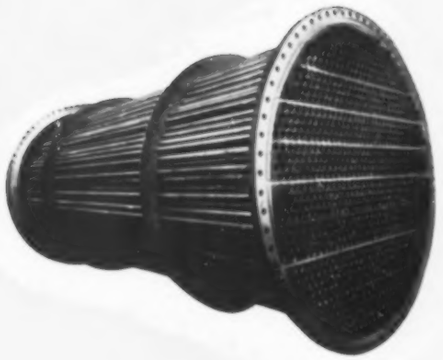

HUMBOLDT

Besides, we supply processing units for all fields of application in mineral oil processing and petrochemistry, such as columns, scrubbing towers, reaction vessels, heat exchangers of all types and designs according to international standards for all pressure stages and operational temperatures.

Humboldt's erecting department with its experienced specialists and all required erection tackle is at your disposal for the erection of the apparatus and plants manufactured by us as well as for the performance of your "shut down" in due time. Our manufacturing workshops are also prepared to assist you in the case of maintenance or repair work requiring an overhaul at our works.

"STAHLBAU" HUMBOLDT supplies steel constructions of any kind, tanks in all sizes for crude oil and mineral oil products, vessels, storage tanks, loading plants and other offsites.

Please, inform us of your problems in mineral-oil processing and petrochemistry. We are prepared to also place our services at your disposal in this field of application.

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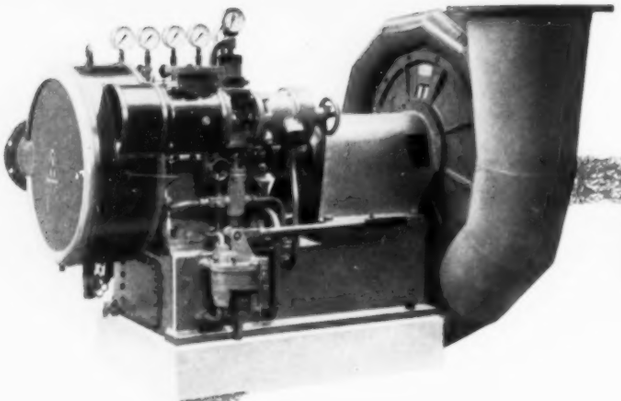
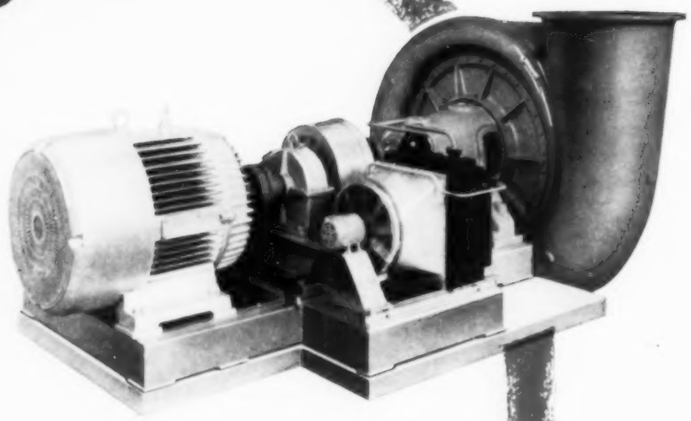
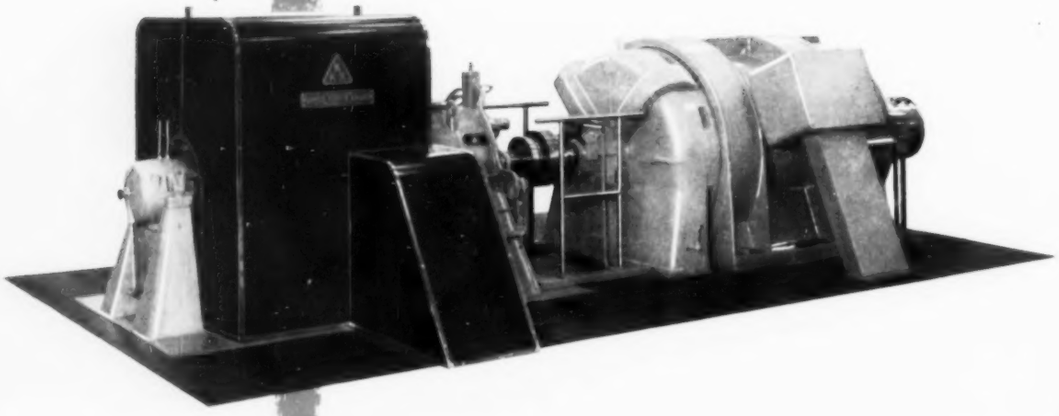


RADIAL BLOWERS



BACK-PRESSURE
STEAM TURBINES



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for Oil Refineries

AKTIENGESELLSCHAFT **KÜHNLE, KOPP & KAUSCH**
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STEAM POWER STATIONS

TURBINES

DIESEL ENGINES

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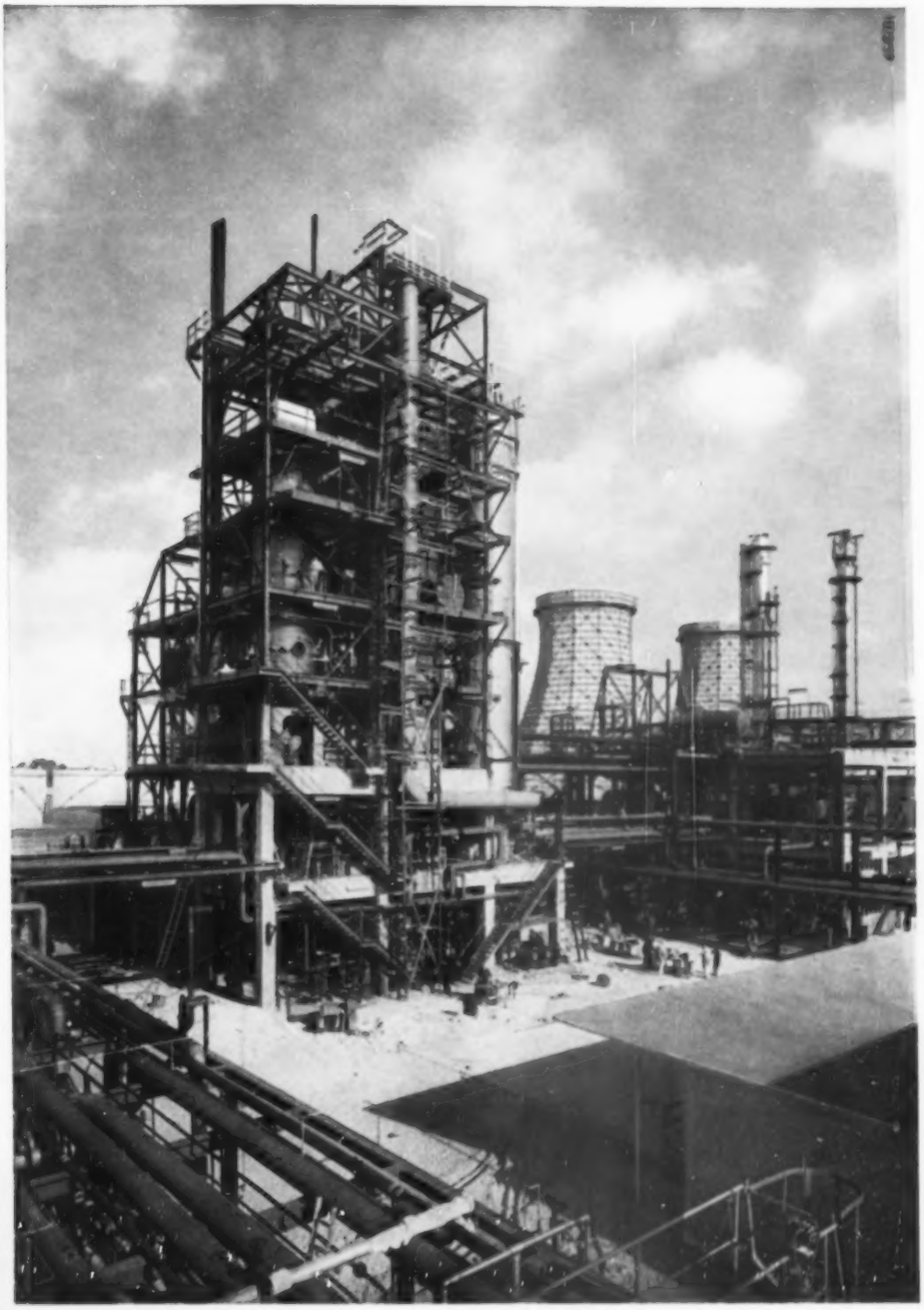

Responsible for process and engineering were:
N. V. de Bataafsche Petroleum Mij., The Hague
and Lummus Nederland N. V., The Hague.
Responsible for purchasing was:
Edeleanu GmbH, Frankfurt.

We recently supplied and installed all apparatuses and structural steelwork required for the

CAT CRACKER AND GAS RECOVERY PLANT
DEUTSCHE SHELL AG
HOHE SCHAAR REFINERY, HAMBURG

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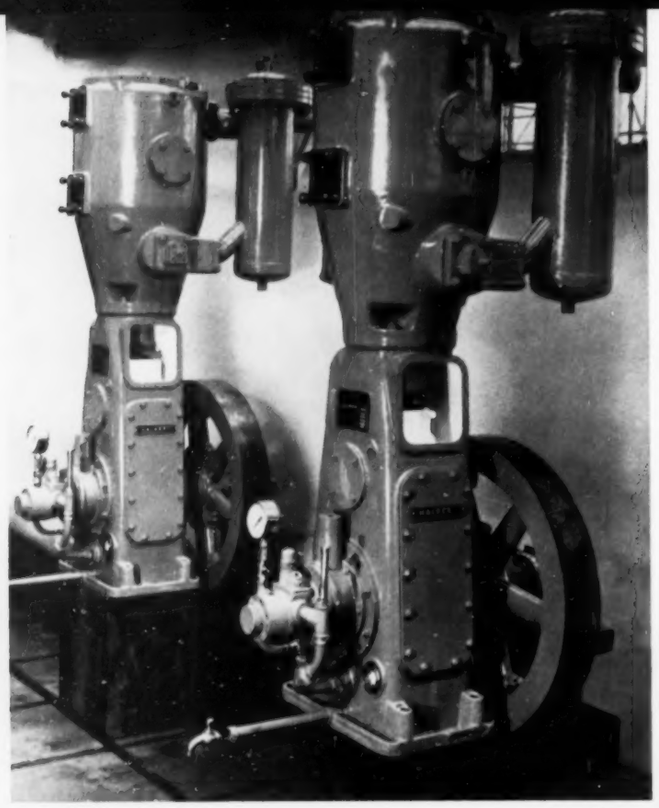


Single stage compressor for recycle gas. Photo courtesy Halbert GmbH, Ludwigshafen

this connection, mention might be made of those refinery processes which, for example, handle refinery gas and the like.

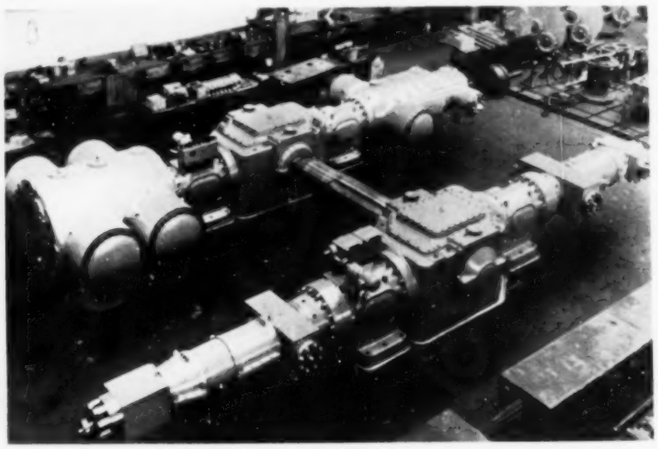
For these processes, compressors for ethane, ethylene, ethylene oxide, etc. are required. Vertical as well as horizontal compressors have fairly large capacities, but a pressure range from about 50 atm.g. (750 psig) upwards. They are driven by electric motors or horizontal or vertical steam engines. The above refers to piston compressors which were directly developed for the petrochemistry; it goes without saying that suitable compressors for any other process and for any pressure can also be manufactured.

Again and again the oil industry engineer has to deal with problems regarding the transportation and the compression of all the different kinds of gases and vapors and must, therefore, familiarize himself with the characteristics of the required blowers, compressors, and pumps. In this particular field, the enclosed compressor functioning in accordance with the Root principle has recently found wide application, since the efficiency and the characteristics of this machine make its use preferable especially because the medium remains absolutely oilfree and has positive volumetric displacement.

In single-stage construction, the pressure ratio goes up to 1.8. By connecting in series of two or more units, the pressure ratio increases correspondingly.

Blowers of standard construction are suitable for all kinds of media such as nitrogen, hydrogen, propane, methane, ammonia, acetylene, carbon dioxide, ethane, etc. In the case of acid or alkaline gases or of high-temperature gases, a separation between gear boxes and bearings on the one side and the volute on the other side is required. Such contructions are suitable for oxygen, chlorine, hydrogen sulfide, butane, SO_2-containing gases, etc. Depending on the properties of the medium, suitable sealing devices are to be used.

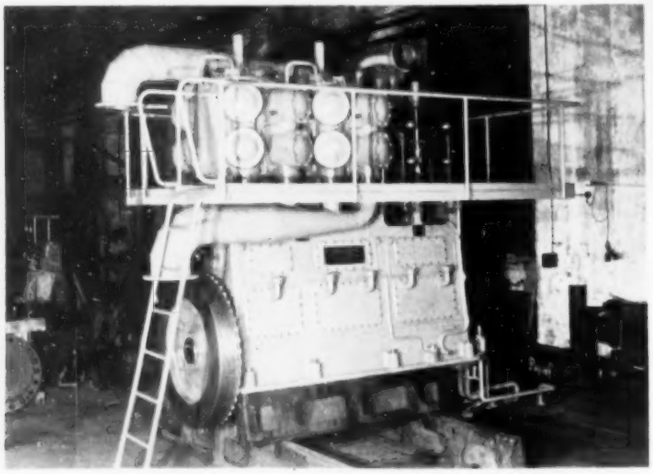
Moreover, there are many different types of turbocompressors, of which the rotary and the screw type compressors in particular stood up best in the service of gas processing in refineries and petrochemical plants. Lubricant and medium are completely separated, so that in most cases the lubricant kept its full lubricating power for two to three years without change and, practically, without maintenance since the oil is not contaminated. The operating elements of the



Horizontal gas compressor with pistons working in opposite direction for petrochemical plant. Photo courtesy Halberg GmbH, Ludwigshafen

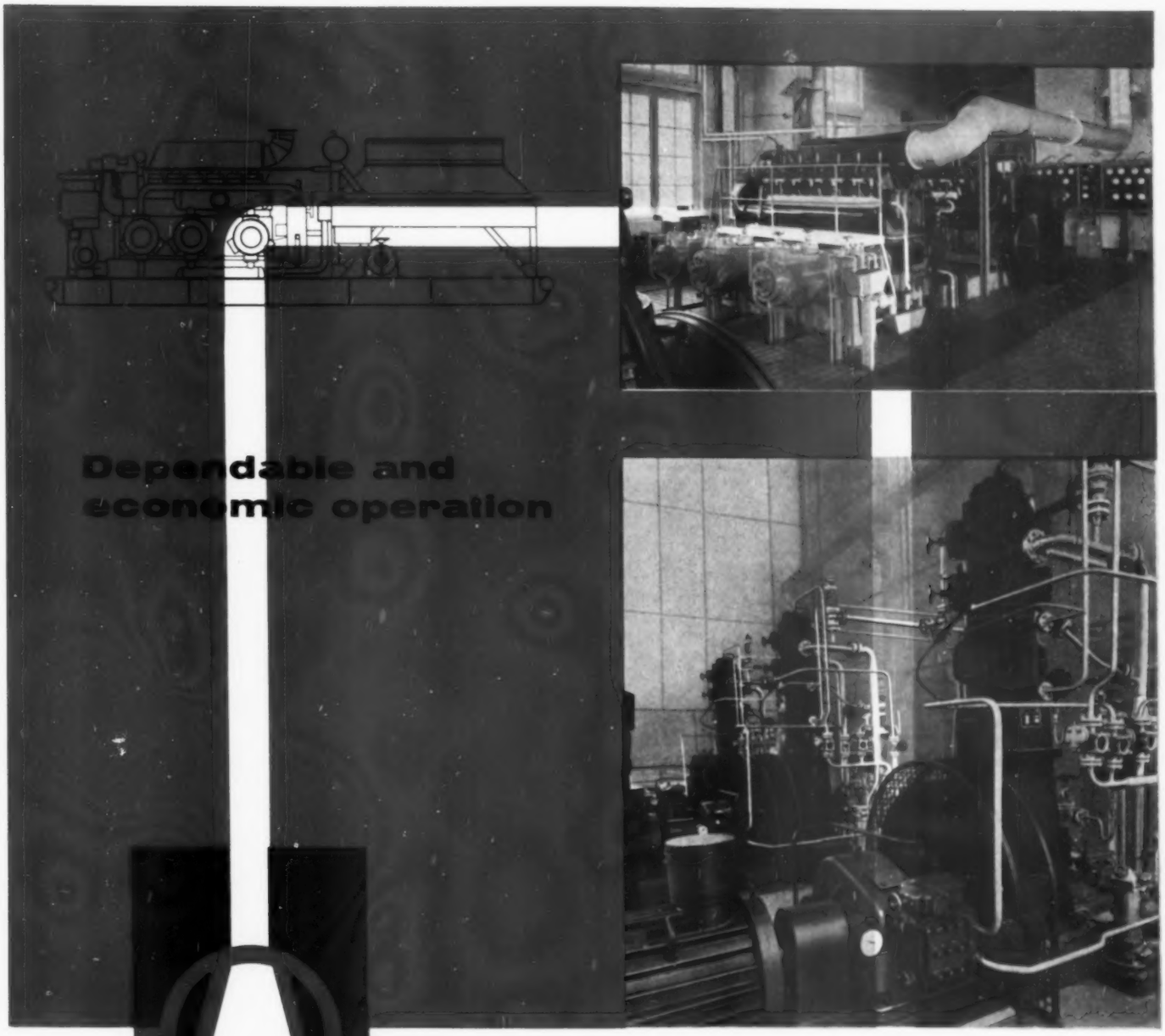
Refinery gas compressor house. Photo courtesy Friedrich Uhde GmbH, Dortmund

Vertical gas compressor. Photo courtesy Halberg GmbH, Ludwigshafen



abovementioned compressors are immune to fouling and sediments, even to carbonization, incrustation, and cementing. The compressors require very little space and only small foundations, and require little maintenance. With regard to the compression of all kinds of petrochemical and refinery gases, experience extending over the years is available.

Screw-type compressors are built for capacities up to 30,000 m^3/h (about 100,000 cu. ft. hr) in single and multiple stage construction for operating pressures up to about 20 atm.g. (about 300 psig); they



Dependable and economic operation

– an essential requirement for gas or Diesel engine driven compressors which have to render continuous service in oil-fields, long-distance gas transport and underground gas storage, and in petroleum refineries. In this respect you can fully rely on the Mannesmann-Meer type, in stationary and skid-mounted design with fan cooling. The compressor part of the unit is designed to suit your specific demands.
Our programme includes a variety of models with ratings of from 200 to 2.500 HP. For similar purposes we also manufacture reciprocating compressors in opposed arrangement or vertical design for electric drive up to the highest pressures and rates of performance.

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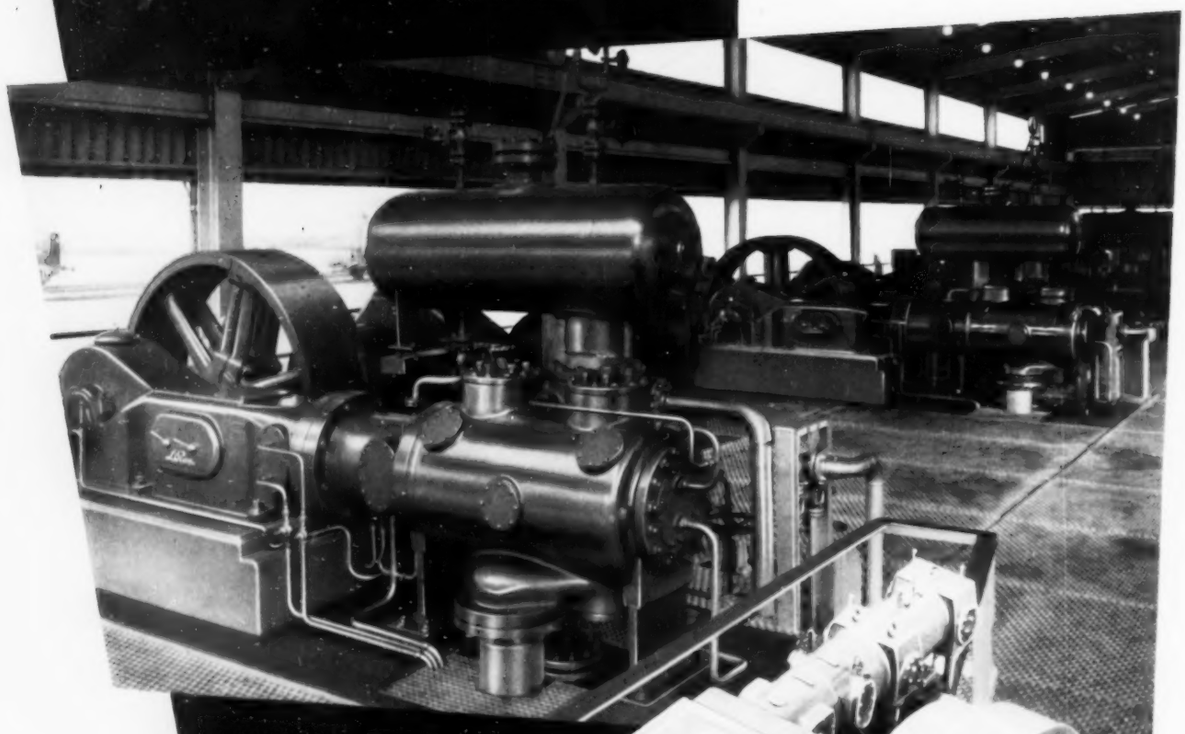
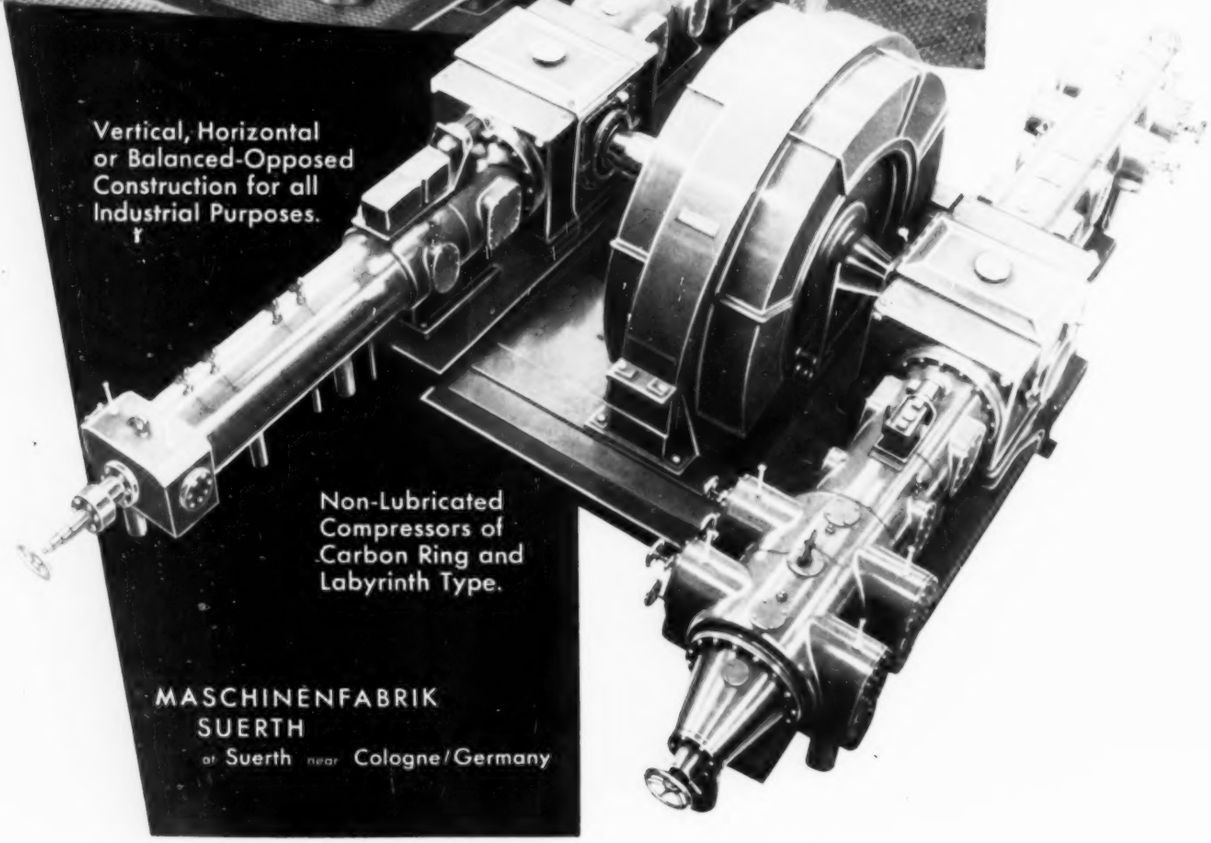
Linde COMPRESSORS



Vertical, Horizontal or Balanced-Opposed Construction for all Industrial Purposes.

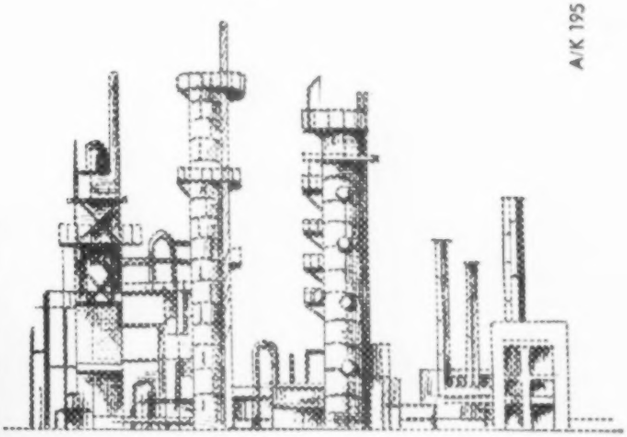


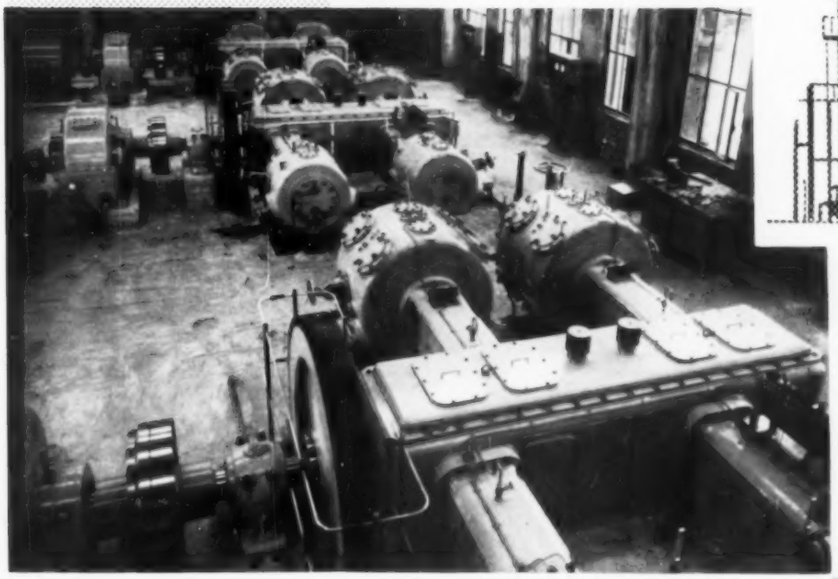
Non-Lubricated Compressors of Carbon Ring and Labyrinth Type.

MASCHINENFABRIK
SUERTH
at Suerth near Cologne/Germany

SIEMAG *makers of compressors for the Oil Industry*

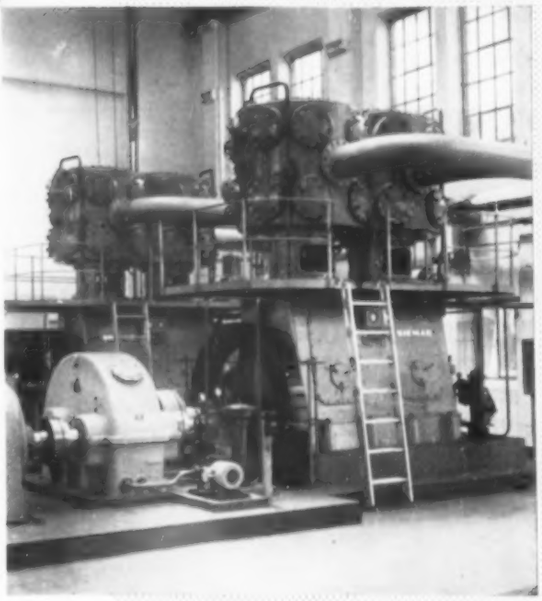
A/K 195





Gas compressors, opposed balanced (Boxer) type, unit capacity 6.000 Nm³/h, with reliable stepless capacity variation.

Vertical gas compressor, unit capacity 10.000 Nm³/h, with dry running (non lubricated) piston.



A Century of manufacturing large piston engines is reflected, besides our large gas engines and steam engines, also in our

High Pressure and Low Pressure Compressors.

Extensive experience over many years has been incorporated in our designs and patents for the most various gases, pressures and applications.

Basic principles embodied in our machines are:

Utmost reliability and robustness
Long life
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Highest economy

We are accustomed to meet special requirements of our clients in different fields, also for unusual applications, because we still value individual manufacture.

High quality of our products and perfect fit of our spares are guaranteed by:

Our own foundry for cast iron and cast steel
Our own mechanical workshops fitted with most modern machine tools
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SIEMAG specialities are:

Large non lubricated compressors with patented dry running piston
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MWM DIESEL

Pioneers in Diesel-Power for Stationary and Mobile Pipe-Line-Units.

MOTOREN-WERKE MANNHEIM AG · MANNHEIM WEST-GERMANY

DIESEL engines have proved successful for many years in the oil well drilling industry. Under the most exacting operating conditions diesel engine has shown that it is a very excellent power supply irrespective of whether the engine is air cooled or water cooled. Technical developments in the production of crude oil opened for the Diesel engine another most important field.

There is a marked trend at present in Europe for pipelines to take over the transportation of crude oil or finished products from the oil fields to the shipping stations and ports or from shipping stations to refineries or even over far distances directly from the oil fields to refineries. For this task in most cases Diesel engines are used to drive pipeline pumps.

If there is no electricity available at the pumping station which could operate electric motors, the diesel engine will power the pumps in a direct drive. Even if electric motor driven booster pumps are concerned, for reasons of security there always will be required an emergency generating unit to insure the conveyance of the oil during failure of the network which could be for longer periods. In this case the diesel engines would be used as prime-movers of the generators.

As a matter of fact, both pipeline work and drilling operation require heavy duty diesel engines. Therefore, we made it our task to construct heavy duty diesel engines for continuous operation most suitable for this kind of work in order to guarantee uninterrupted conveyance and haulage of the oil.

Both the transportation of oil to the refinery and the transportation of finished products to the users are equally important in the haulage of oil.

If the pipelines traverse vast areas through undeveloped country there is no better prime-mover for the pumping stations than the diesel engine visit with its ideal range of speed regulation and adjustment.

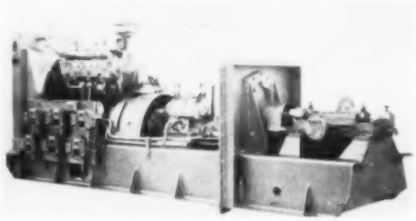
There is another unequalled advantage if the pipeline carries products which can be used as fuel for the diesel engines. Thus, the fuel supply of the pumping stations is considerably facilitated as the storage tank can be fed from the pipeline.

The diesel engine always will make a pumping station independent of all exterior influences and guarantees action also in case of catastrophes. This applies to direct and indirect drive as well. For this reason military plants by no means can do without diesel engines.

After years of development, experiments and tests **MWM** have a comprehensive program of diesel prime movers specially designed and suitable for pumping oil. In the very beginning problems had to be solved that formerly hampered the use of diesel engines in this field. Attention had to be paid to a suitable protection against explosion, considering at the same time the different products to be transported. The supervision of operating functions, automatic regulators and special cooling systems also had to be taken into account. Tests are carried out continuously to find out whether different products conveyed in the pipelines cannot be used as fuels for the diesel engines.

The **MWM** power range of diesel engines with special equipment for pipeline prime movers and pipeline auxiliary units covers 50 to 700 hp. Of course, this power range can be increased considerably when using twin or triple installations. For output details please refer to data listed below:

Diesel engines with special equipment are available for the following purposes: (1) diesel engines as prime movers of pumps in booster stations; (2) diesel engines as prime movers of pre-pumping units, circulating or suction pumps in tank farms; (3) diesel engines as prime movers of generator units installed in booster stations or tank farms.



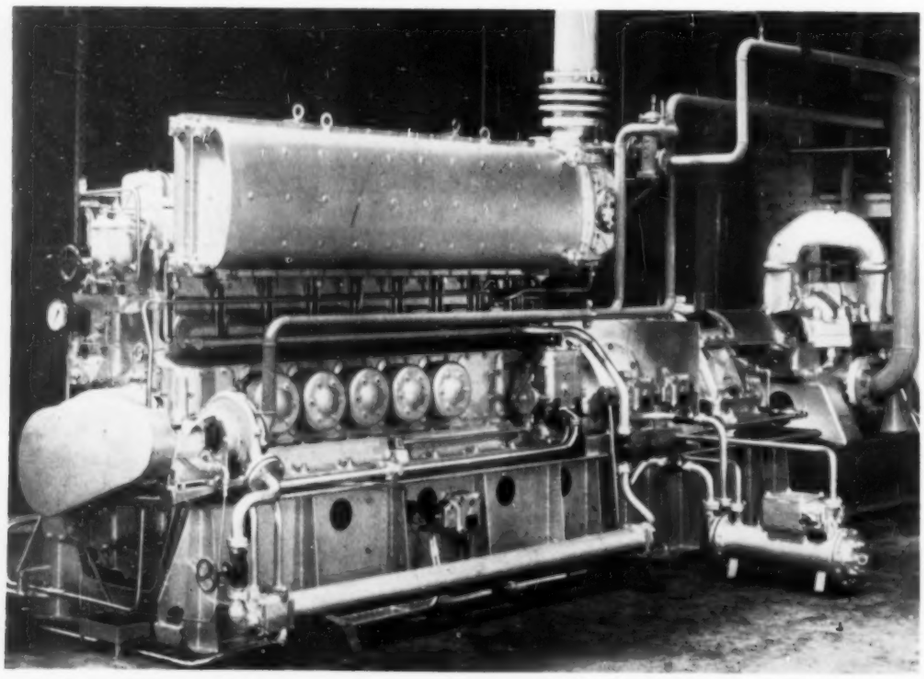
Diesel-pumping-set RHS 518 D, 87 HP, explosion-proof, with pump of make WORTHINGTON for tank-station (fan-cooling).

Many engines have been operating perfectly for long periods under these heavy duty conditions.

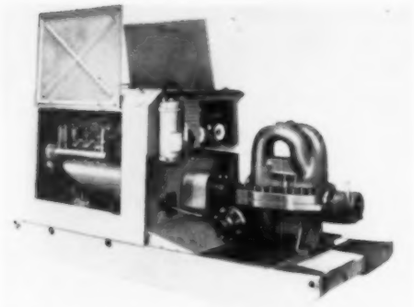
Taking into consideration the three aforementioned examples, we have set up the following basic requirements for our manufacturing program: (1) design of standard types to facilitate service and storage of spare parts; (2) application of heavy-duty type engines which guarantee operating security of the plants in which they are installed; (3) keeping well below a piston speed which is completely controlled by today's technical standards; (4) construction of units to facilitate the exchange of single parts without difficulties; (5) construction of the whole unit in a way to make it easily transportable and quickly replaced; (6) development of different explosion protective devices on the engine which are in accordance with all ruling standards and, therefore, can be approved by all classification authorities.

Thus far **MWM** has supplied about 1,000 cylinder units for pipeline service. Although the power requirements differed widely, only a few engine types had to be employed. As MWM uses the same elements for each of its different engine models it is possible e.g. to cover a range from 50 to 700 hp with the very same engine type. 50 hp are produced by a twin-cylinder engine of the type 518 and 700 hp are produced by a supercharged 16 cylinder V-engine of the same type. This results in great advantages with regard to service and storage of spare parts which are, as mentioned before, basic requirements for pipeline service.

Diesel-pumping-set TRHS 526 A, 435 HP, explosion-proof, with pump of make WORTHINGTON, for Booster-station.



Diesel-pumping-set RHS 518 A, 230 HP, explosion-proof, with pump of make WORTHINGTON for tank-station.



Monile Pipeline-Pumping-Unit with MWM air-cooled Diesel engine AKD 412 AV, 126 hp, for multi-fuel operation.

Description of the different applications

1. Diesel engines as prime movers of pumps in booster stations.

It has been found most useful if diesel engine and pumps are assembled on a common baseplate. Should ruling safety regulations require a separation of engine and pump room it is easy to fit a gas-tight bulkhead on the baseplate and incorporate the bulkhead in the separation wall of the rooms.

It also has proved very useful if the common baseplate of engine and pump is split into two parts at the coupling in order to ensure a quick separation of the unit in case of engine or pump trouble. A defective pump or engine can be taken away and replaced with its base in a minimum of time.

The lower engine speed is adjusted to the pump speed by a gear box. It is advisable to use specially toothed gears with spur-wheels which are manufactured to answer this purpose.

To keep away shocks from engine and gear, flexible couplings are fitted between pump and gear as well as between gear and engine. The couplings are overdimensioned and supported by external bearings. The flexible coupling between pump and gear is bi-parted so that either part can be taken away without shifting the pump on its base.

One of the most important problems, the tuning of engine and governor automatics, has been solved and the installation of special devices resulted in a unit that works perfectly.

Most importance must be attached to the supervision of the engine. This is necessary to guarantee trouble-free operation. There is a pre-alarm that registers any disturbances even if there is no acute danger for the working reliability of the engine. Thus, it is possible to remove the cause of failures without interrupting the operation of the unit.

Depending on safety regulations exhaust silencers usually must be equipped with spark catchers and the exhaust piping must be installed in a way that the regulations concerning the surface temperature are adhered to. It also was necessary to have a special duct for the aspirating air.

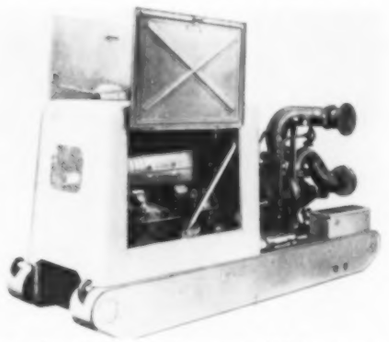
Protection against explosion has been developed for the different engines to comply with various rules. It will not be possible in this connection to describe the measures taken as they had to be different almost in every case. It may be stated, however, that protection against explosion can be adapted to any prevailing rules as the basic execution is designed and based on the strictest regulations known to us.

For the cooling system of the engine we developed a special heat exchanger which is cooled by the material to be conveyed in the pipeline. The cooling system is very simple, does not need any additional power, and does not need to be specially protected for operating industry atmospheres.

The heat exchanger is tested at a pressure of 120 atm. which compares to the usual operating pressure of 84 atm. It is possible to adjust the heat exchanger to higher operating pressure.

To permit a test run of the diesel engine before the pipeline is being filled, a special cooling system was developed which permits a perfect test of the engine functions even if the booster pump is disconnected.

Total capacity of a pipeline station is split among several pumping units. One station usually comprises three to five diesel pumping units. A special piping system for cooling water permits all engines to be fed from one heat exchanger. In most of the cases this heat exchanger is also used as a heating plant which has sufficient cacapity to heat the engine room during operation.



Mobile Pipeline-Pumping-Unit with MWM air-cooled Diesel engine AKD 412 V, 41 hp, for multi-fuel operation.

After long periods of standstill, however, it is advisable to have the engines pre-heated before operation. The engine life to a large extent depends on preheating which avoids cold starting. The starting system can be simplified if the diesel engines are connected to the same compressed air receiver system.

2. Diesel engines as prime movers for tank farm pumps.

The equipment of the units for tank farms roughly is the same as for booster stations. Only the cooling system is different. Instead of a heat exchanger system usually a radiator fan cooling system is used. The radiator is either fitted on the engine or installed separately. The radiator also can be combined with a heating system for the engine room. At the same time the fan of the radiator can be used for ventilation of the engine room which again simplifies the total installation.

The arrangement of the bulkhead in accordance with explosion safety rules is the same as already described for booster stations. Units for the tank farms are also assembled on a common baseplate hence easily transportable and exchangeable.

In this case a special automatic regulating device is not necessary. The units usually are manually operated.

3. Diesel engines as prime movers of alternator sets
(in connection with tank farms or booster stations)

If tank farms or booster stations cannot be supplied with electricity from a public network it is necessary to design the diesel pumping units for continuous operation.

If the system is connected to the public network the units will be designed as emergency sets and must be equipped with automatics which, should the public network fail, guarantee the immediate start of the alternator set and the immediate supply of electricity for the station.

In order to comply with safety rules against explosion a special design had to be developed for the alternator sets. Again there is used a gas-tight separating wall with a bulkhead duct. The alternator sets of this special design are not bigger and not more expensive than the normal units.

If the pipeline conveys JP 4, the diesel engines used in the stations can be designed in a way that they can burn JP 4 as fuel. Thus, all engines working in booster stations, in tank farms as prime movers, or diesel alternator sets in tank farms can be operated on the fuel transported in the pipeline or stored in the big tanks.

4. Diesel engines in pipelines of small capacities.

To standardize the engines in different stations generally water-cooled engines must be used because of the big capacities required. However, in small lines air cooled engines can be incorporated without difficulties. Thus, air cooled engines would be used in supply pipelines which transport fuel to big building sites or in preliminary pipelines for crude oil which work as a stop gap until the big pipeline with stationary plants is erected. In such cases it is advisable to adopt transportable pumping units powered by air cooled diesel engines.

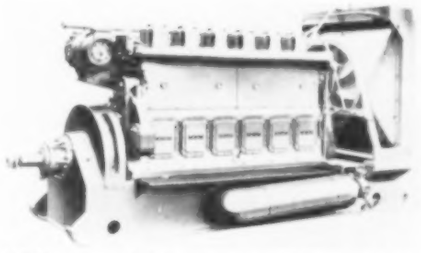
If the engines are installed in product pipelines which pump diesel oil, JP 4, petroleum, gasoline, or similar products the engines can be designed to operate on these fuels.

These transportable units consist of a diesel engine with incorporated disengageable clutch flexibly coupled to the pump. The diesel engines will be high speed engines. Thus, no gear will be necessary.

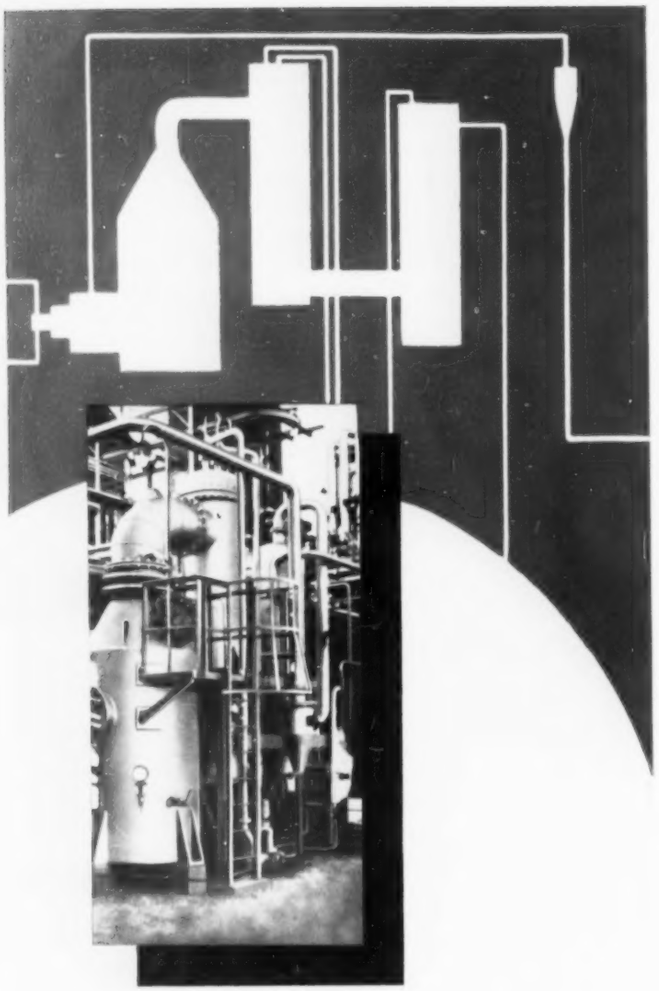
In order to protect the engine from atmospheric influences it is surrounded by a weather proof casing.

Although this unit can be easily transported, it is equipped with all the supervision devices and an automatic push button operated regulation as the big stationary plants. For this reason the operation of the small plant is very easy and can be done after a short training by the standard personnel without difficulties.

Our long experience in this special field has been used also for the construction of these small units, and they are foolproof in their different application possibilities.



MWM water-cooled Diesel engine TRHS 230 S, 400 hp, for oil-drilling installation.



Plants for the generation of protective gas to be used as auxiliary and fire protection process agent. This protective gas is obtained by combustion of fuel oil, natural gas, refinery gas like methane, ethane, propane, butane and of industrial gas like blast furnace gas, coke oven gas, producer gas etc.

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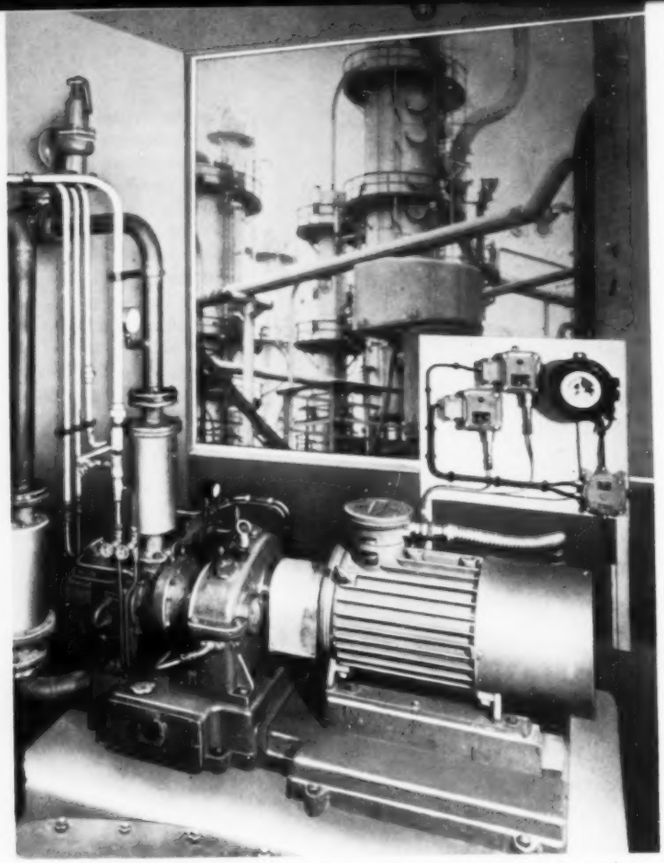
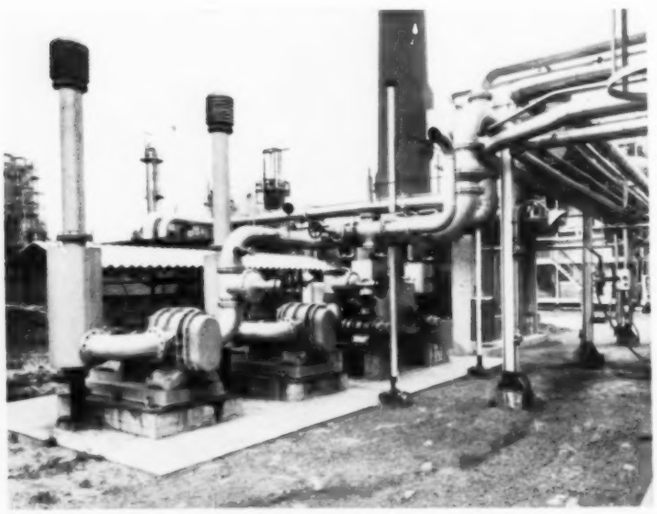


Compressor for oil-free instrument air (6 m³ minute; 210 cu.ft. min.). Photo courtesy Aerzener Maschinenfabrik GmbH, Aerzen

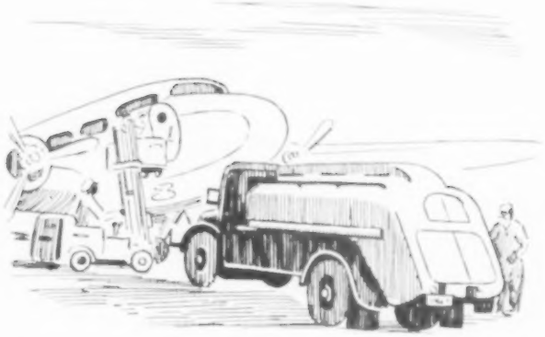
are suitable also for vacuum operation. In view of the fact that for most compression problems the output of the compressor shall remain constant with varying backpressure, the rotary piston-type compressor meets this requirement best. In the refinery and petrochemical industry, this type of compressor has for many years been preferred because of its operating reliability and especially its immediate readiness for operation.

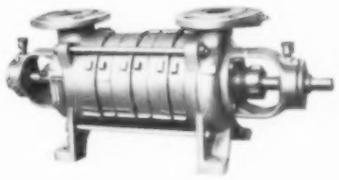
The above enumeration is by no means an exhaustive summary with regard to the field of activity of the German compressor manufacturers; however, we regret that the allotted space does not permit us to mention and specify all types. It might finally be stated here that, in the program of the German manufacturers of compressors, an appropriate and economic solution can be found for every compression problem—even for extremely high capacities and or operating pressures and extreme temperatures.



Set of rotary compresors for air and H_2S (capacity 50 m³ and 15 m³ per minute resp., 1770 cu.ft. and 530 cu.ft. per minute resp.). Photo courtesy Aerzener Maschinenfabrik GmbH, Aerzen

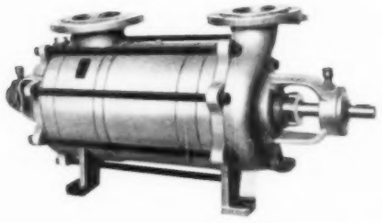
SELF-PRIMING FUEL PUMPS Sihi

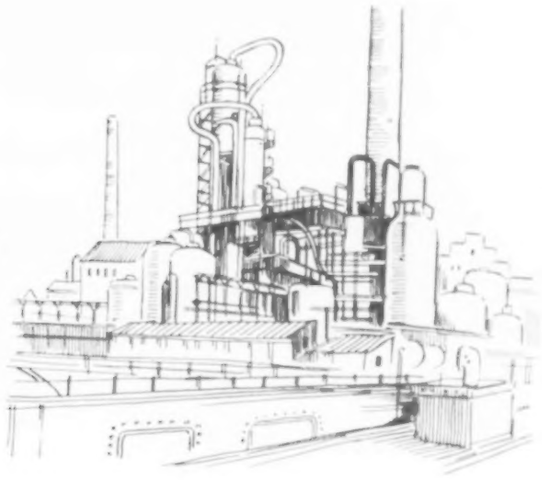




Sihi centrifugal pump
construction A,
for tank plants, large filling stations, fuel transfer from ship to lighter, airplane etc.

SIHI SIEMEN & HINSCH MBH . DEPT. 85 . ITZEHOE/HOLSTEIN **SIHI** SIEMEN & HINSCH MBH . DEPT. 44 . ITZEHOE/HOLSTEIN **SIHI**





Sihi centrifugal pump
construction ZAI,
for oil refineries and large storage tank plants

SIHI SIEMEN & HINSCH MBH . DEPT. 85 . ITZEHOE/HOLSTEIN **SIHI** SIEMEN & HINSCH MBH . DEPT. 44 . ITZEHOE/HOLSTEIN **SIHI**

Sihi filling column pumps
AOV 3111,
for mounting into filling columns

SIHI SIEMEN & HINSCH MBH . DEPT. 85 . ITZEHOE/HOLSTEIN **SIHI** SIEMEN & HINSCH MBH . DEPT. 44 . ITZEHOE/HOLSTEIN **SIHI**

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9 Insulation

LIKE any plant in the chemical heavy industry, a refinery is very sensitive to heat losses. Any losses by radiation must be avoided. Products with high pour points must be protected from freezing and solidifying. For these reasons extensive insulation is required on many kilometers of piping and on numerous vessels.

Piping has its special problems. Designers are always required to tackle a number of tasks related to the laying and length of pipelines and to local climatic conditions. For reasons of heat economy, insulation plays an important role in these considerations because it is one of the major factors that influence the rentability of a plant.

Efficient insulation of piping not only prevents an undesirable temperature drop to the pour point of the products, it also cuts expenses for heat requirements in general. It is advisable to consult experienced insulation specialists as early as in the planning stage of the plant to come to a decision on the kind of insulating material to be used, the type of metal jacket and special details to be considered in each individual application.

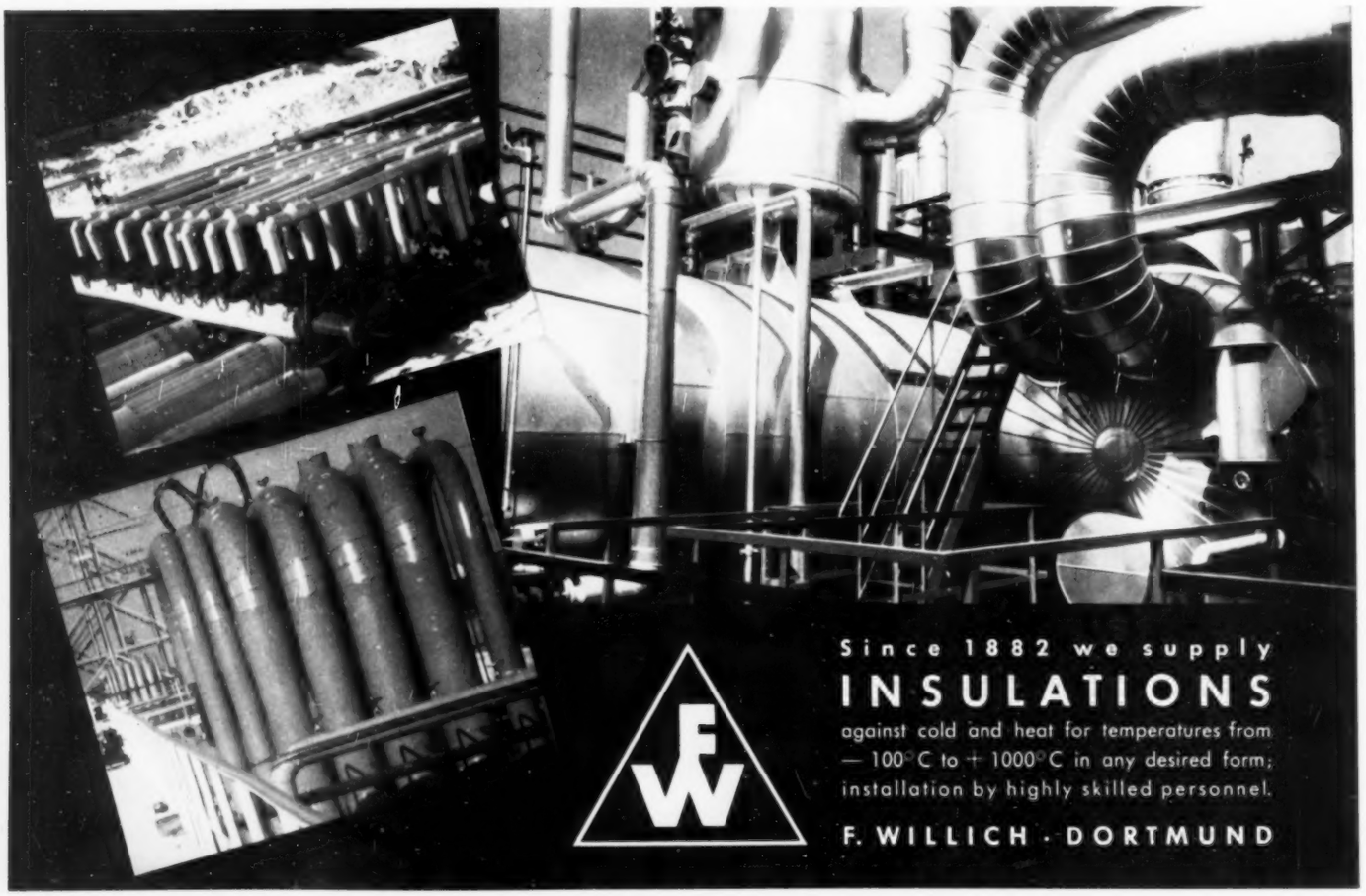
Therefore, for economic considerations alone it is essential to take care at the time of construction of piping and vessels to provide sufficient space for thickness of future insulation and for the insulation erectors to apply the insulation. There are still other very important problems such as the protection against humidity of the insulation on underground piping, flanged valves and pipe supports that can be clarified in good time in cooperation with a specialized company so that due consideration may be given to all details at the time of construction.

Pipe supports for long pipelines require particular attention. Bare pipe supports cause an excessive rise in heat transfer from the oil. It is easy to appreciate clearly the heat loss on the basis of the simple fact that a single pair of bare pipe flanges radiates as much heat as about 6.5 ft of insulated piping.

The insulation of vessels and equipment in refineries is still more important. In general, the area to be insulated on vessels and equipment varies from 20,000 to 30,000 square meters. Fireproofing of supports and structures adds to the insulation requirements. Special experience is needed for any application of low temperature insulation in petrochemical plants and gas fractionation plants.

The tall cracking towers are no doubt the most prominent structures requiring insulation in a refinery. Peak temperatures to be maintained here are 900 to 1100° F. Requirements in the high-temperature range are similar to those encountered in modern power stations. Therefore, steam lines in refineries do not essentially differ from power plant piping and heating lines. As an approximate figure, steam lines account for about 30%, oil lines of any kind for about 70% of the entire piping system in a refinery.

Besides taking into account the very high temperatures and the very low temperatures, it is therefore essential not to neglect any temperature difference whose magnitude is only about 50° F, but which is characteristic for most of the piping and vessels. For economic reasons the enormous extent of the areas to be insulated in a refinery makes it imperative in the initial stages of plant design and layout to study the problems of thermal and low-temperature insulation and to devote full attention and utmost care to this section of the planning work, too.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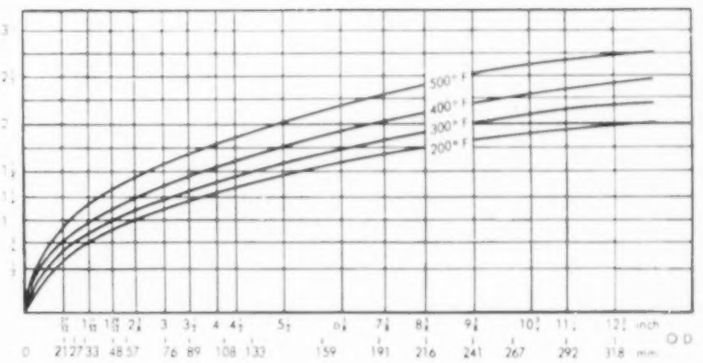

ANY building program for the construction of oil plants or refineries includes—last but not least—the insulation of fittings and pipe systems. This insulation represents the final finishing touch to the complete work, meeting technical requirements as well as improving the appearance of the plant.

Influencing amortization time

The reduction of fuel consumption to a possible minimum is a focal point in all technical problems. Saving in energy consumed must justify the cost of insulation during the life of the plant. These savings, however, are a function of the quality of the insulating material applied and depend largely on the competence with which the work is done. The constant growth of insulating techniques requires a big firm to keep abreast of all new developments.

Quality of insulation material . . . first and foremost

Advanced insulating technology values, above all, the excellence of the insulating material applied for pipeline and tank coverings. Our company claims to manufacture in its various factories a mineral fiber, developed in our laboratories and research plants especially for insulation in large scale industrial installations. This product, SILLAN, longfiber rockwool, has withstood severe tests for about 15 years. A careful choice of raw materials guarantees excellent properties. This soft, long fiber rockwool is easy to work and is noted for its high resilience, which accounts for its resistance to compaction by constant vibration. The temperature resistance of SILLAN, up to 1300 F (700 C), is high enough to cover the whole possible range of heat insulation which may be required in a refinery.

Guaranteed insulation effect

As SILLAN is water- and fireproof and is not affected by aging, it has an unchanged insulation efficiency without time limit. Tests on pipelines in the open have shown heat transfer rates identical to those obtained five years earlier at the time of installation.

Reduction of tolerance by prefabrication

Hand packed insulation is not recommended by Grünzweig + Hartmann, since the efficiency of the insulation increases obviously with the uniformity of its structure. It is for this reason, that SILLAN mats on galvanized mesh wire or prefabricated sections (such as SILLAN pipe sections, slabs and felts) are more efficient than packed insulations. The insulating cover is so homogeneous, that the calculated values can be realized without any allowance for failure due to labor. The addition of

Pipelines can be effectively and firmly insulated with SILLAN long fiber rockwool on galvanized mesh wire in sheet metal covering.

resinous synthetic materials improves the fundamental qualities of SILLAN sections. The structure gains in uniformity and resilience increases. These are basic requirements of an effective insulation including a matter of considerable importance: the facility of fitting.

The most economical insulation thickness

Values shown in the chart (plant working continuously for 800 hours/year) should be taken as the minimum value for the insulation thickness to be used, as one often has to reckon with higher costs of heat than the costs on which the original calculations were based. It will often be found, therefore, that considerable saving is possible, so it would be desirable to increase the thickness of the insulation layer after expert calculation. For special requirements of a particular plant, the most economical insulation thickness based on the costs of heating and the number of hours of plant operation per year can easily be calculated afresh in this way. Special technical conditions, such as maintaining a definite temperature drop, the prevention of moisture condensation or the necessity for a particular surface temperature, call for special calculations.

Generally the thickness of the insulation has to be calculated with an adequate safety factor in order to maintain a certain temperature gradient. As a consequence there are savings in respect of pumping and heating installations, the number of which can either be reduced or their power capacity curtailed.

Importance of good erection

The execution of insulating work, as carried out by our engineering and technical staff, represents a standard based on world wide experience. Production plans and supply are always ruled by careful calculation.

In order to have the full benefit of the insulating properties of the rockwool it is among other things essential to choose the most suitable spacers for insertion between pipe and sheet metal jacket, to properly calculate the thermal conductivity of the supports and to be fully conversant with the problem of the influence of moisture.

In addition qualified experts of Grünzweig + Hartmann, who are ready for employment all over the world, will carry out insulating work with the greatest exactness. Our engineering and technical staff is selected and trained to act as supervising and instructing staff for local contractors and workmen.

We are, of course, able to offer all requested coverings but we recommend in addition to hard casings, casings of sheet metal. Sheet metal covered insulation is highly resistant to heavy mechanical demands, prolongs the service life of the plant, is fireproof and of smart appearance.

Forming the face of an oil plant insulation

Fortunately perfect insulating work displays a good outward appearance. It is quite to the point, to speak in this sense of "Insulation-architecture". There is no oil plant manager or engineer, who would be indifferent to the appearance of his plant. The architecture of transmission systems and tanks required for the petroleum industry are certainly impressive marvels of technology. The 400,000-500,000 sq ft of insulation surface in a refinery determine the appearance of the plant. It is the insulation, which outlines the appearance of an oil plant.

The future

Somebody dropped the remark that all that matters to an oil man is the efficiency and the cheapness of an insulation, not its outward appearance. We do not believe that! A good appearance guarantees irreproachable workmanship. Customers and technicians of the petroleum industry know this very well! And that is the reason why the future belongs to up to date insulation in a modern industrial line.

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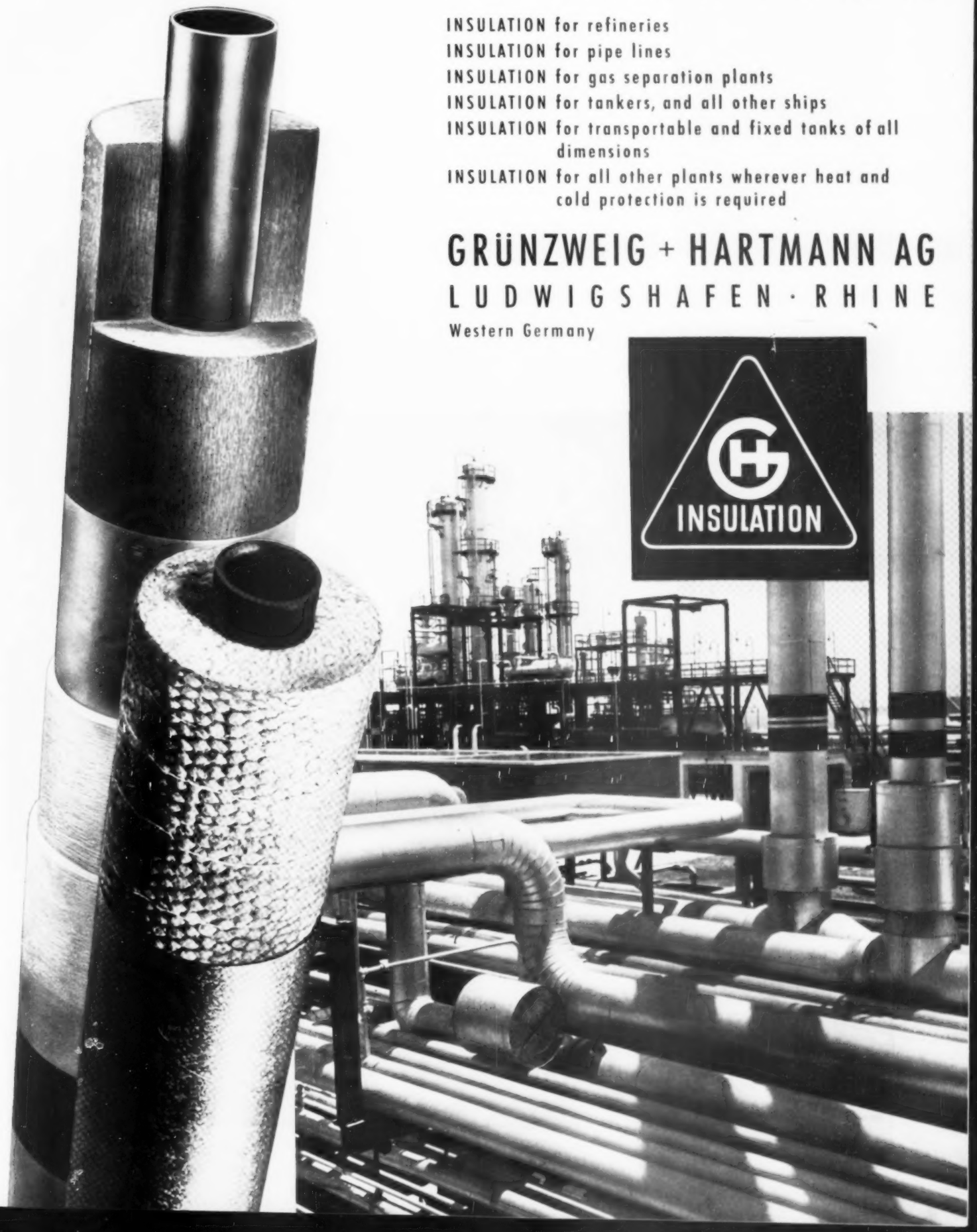

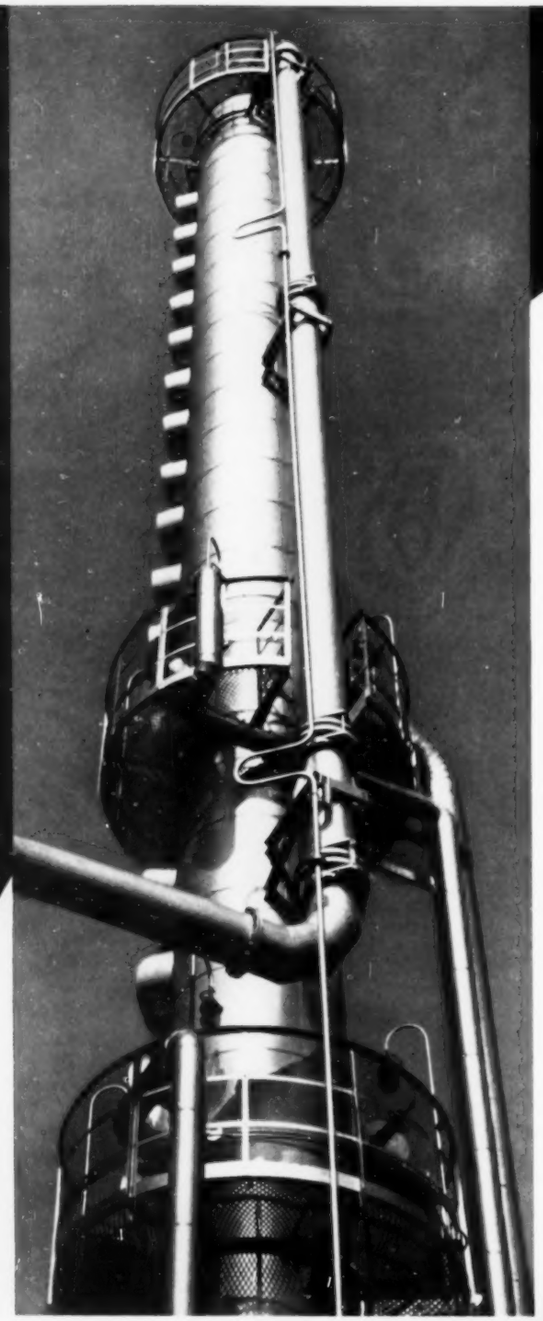

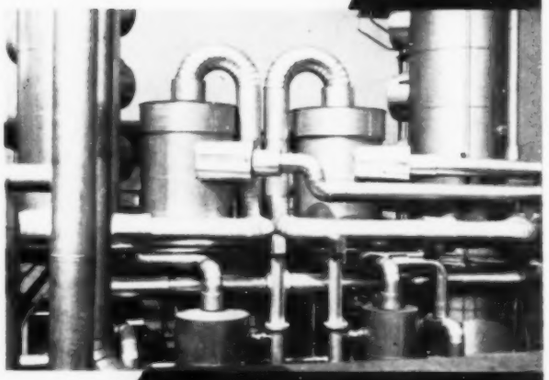

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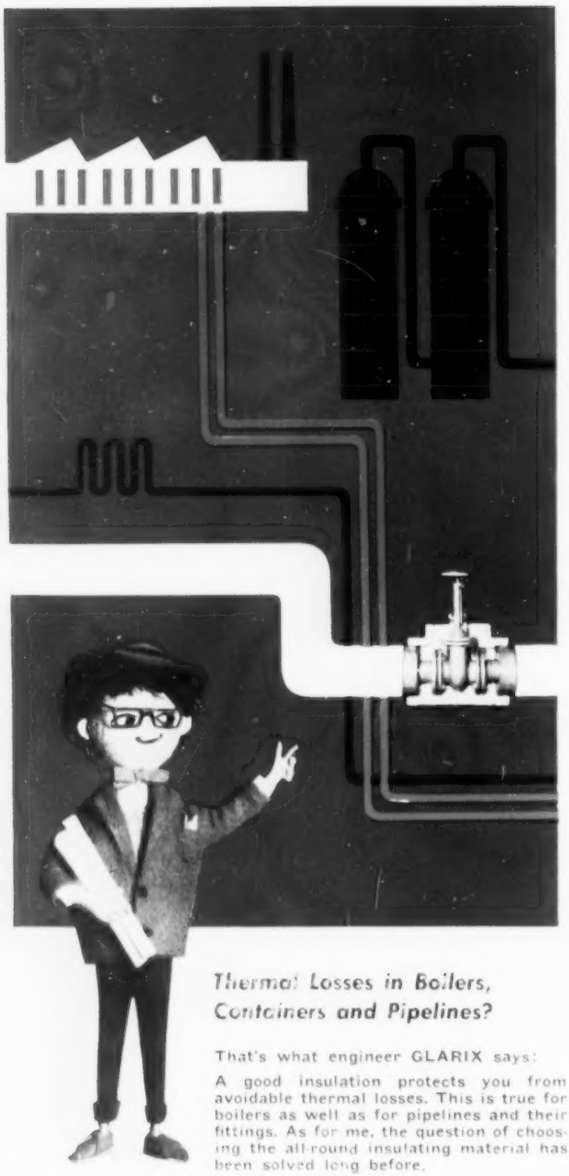

Thermal Losses in Boilers, Containers and Pipelines?

That's what engineer GLARIX says:

A good insulation protects you from avoidable thermal losses. This is true for boilers as well as for pipelines and their fittings. As for me, the question of choosing the all-round insulating material has been solved long before.

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(By the way, did you know that the "Explorer," the first US satellite to be sent into space, was insulated with glas fiber?) Yes, glas fiber is an excellent material of high insulating value, which offers the additional advantage of low cost and economic application.

My advice: Request the free 28 page bulletin "GLASFASER zur Isolierung von Kesseln, Behältern und Rohrleitungen" T 15/34, quoting this journal.

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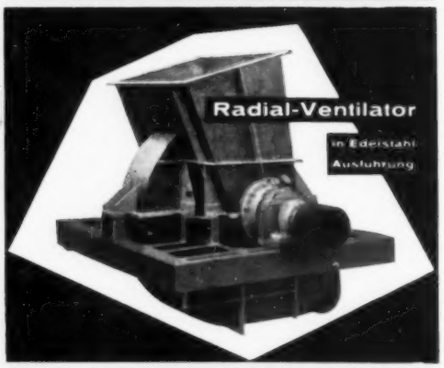
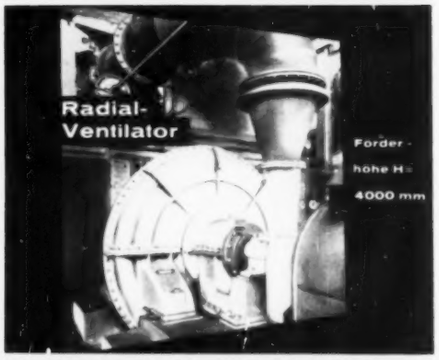




Axial-Ventilator mit einstellbaren Laufschaufeln

10 Inert gas plants and fire protection

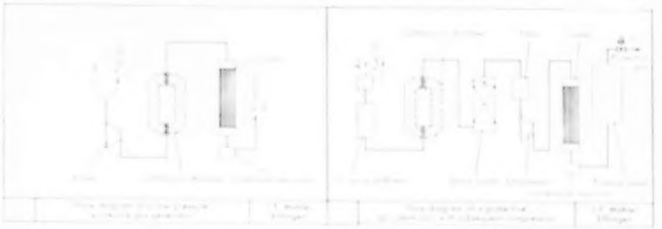
The processing of crude oil and of its fractions in the various process stages of a refinery or petrochemical plant involves necessarily the formation of large amounts of highly explosive gases or the presence of highly explosive vapors at one or more stages of the process from evaporation to condensation. Any leaks in process piping or in the staffing boxes of pumps, compressors, blowers, etc. allow these gases and vapors to come in contact with the oxygen of the atmosphere. Therefore, provision is made throughout the plant for explosion proof designs and grounding systems to prevent electric charges and the formation of electric sparks which might ignite inflammable mixtures.

Still more difficult is the control of large quantities of exit gas and vapors which reach the atmosphere through relief valves and tank breathers. Gas and vapors blown off through relief valves are directed into stacks or burnt in flares. One of the most difficult problems is the breathing of tanks. Moreover, at the time of each start up, piping and vessels contain enormous amounts of air which must not reach the products. For these reasons, all storage tanks receive an inert gas blanket to prevent both the breathing of explosive gas and vapors into the atmosphere and the inrush of air into the tanks. At any time during start up or shut down utmost care is required to eliminate the presence of inflammable gas or gaseous mixtures in any section of the process plant. Inert gas is again an efficient precaution to exclude this danger. Equal care must be taken in the event of repair work and it is essential not to do any repair work on such equipment, until it has been amply purged with inert gas. Additional precaution is needed in the case of welding operations and any work, where an open flame is used.

In many instances, inert gas is used as a process auxiliary, e.g., to protect any products which are sensitive to oxidation, or to prevent the access of oxygen to gases and vapors in solvent recovery operations. All these precautions should be carefully observed in the operation of refineries and petrochemical plants to safeguard against injuries to personnel and destruction of plant equipment.

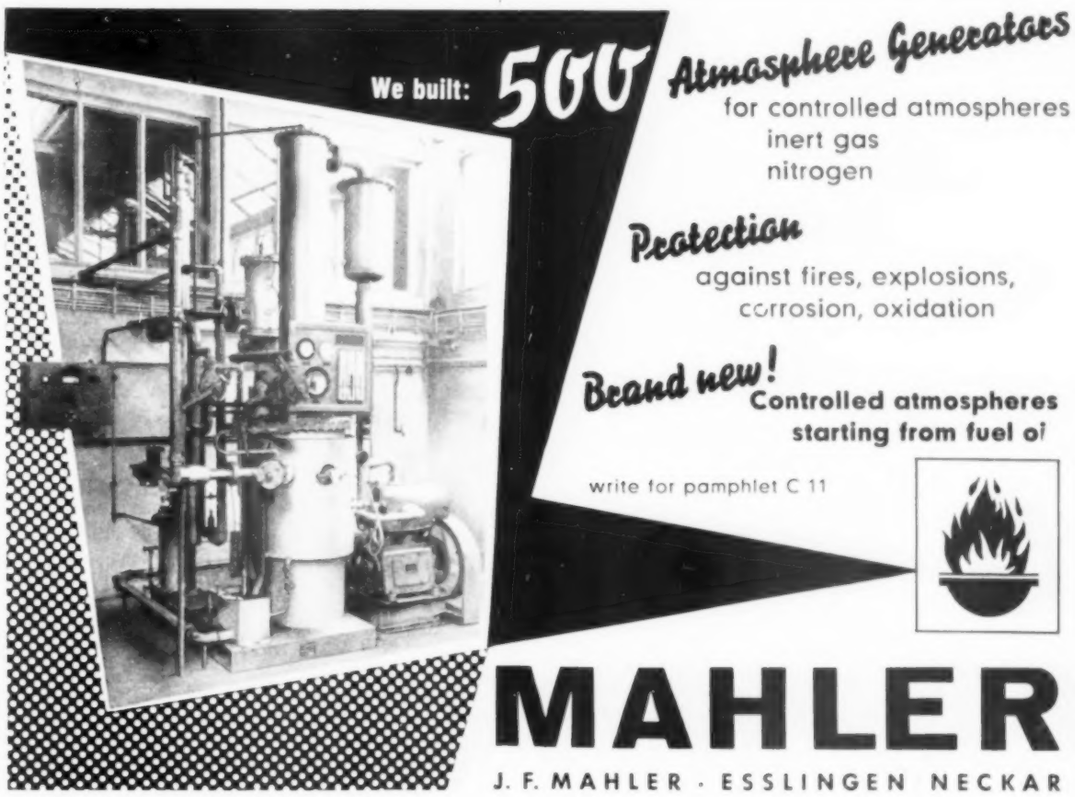
The modern oil industry is using almost exclusively inert gas produced by a suitable combustion of gas mixtures or oil in brick-lined combustion chambers. Exhaust gas from internal combustion engines nromally cannot be used, as there is no safeguard for the absence of oxygen in this gas in all ranges of speed and output of the engines. Similarly, boiler flue gas is usually inadequate and requires, at least, an after combustion, as the freedom from oxygen cannot be ensured in any other way.

Inert gas plants are built in a variety of sizes. They are normally gas fired, using dry gas such as hydrogen, methane and ethane; in some cases liquefied gas is used such as liquid propane or liquid butane which, however, require particular care with regard to burner design and fuel mixture to avoid the formation of carbon black and residues of unburnt hydrocarbons. Inert gas plants also use other liquid fuels of any kind from gasoline to heavy fuel oil. The two



flowsheets illustrate the most common processes employed in inert gas plants.

Automatic control is provided for inert gas plants to ensure a permanently uniform composition of the inert gas. The control equipment in inert gas plants has to meet very stringent requirements not only with regard to the allowable residual percentages of oxygen and carbon monoxide, they must also be capable of maintaining a uniform composition of the gas at any output from 30% to 100% of design capacity.



11 Technical accessories wire rope bolts, nuts, etc.

An innumerable variety of technical accessories are among the requirements encountered in the building of refinery or petrochemical facilities. These accessories are required by tons both for field assembly and shop fabrication of machines, plant and equipment. It is impossible to enumerate the names of all these components which add to the construction of a complete plant.

Bolts, nuts, washers, keys, splines, tapered pins, wire ropes and chains, gears, racks, lifting jacks, winches and hoists, conveying and transport facilities, grease fittings, oilers, and lubricating oil pumps, ball- and roller bearings, pillow block bearings, bearing blocks and speed transmission gears, anchor bolts, anchor rails, base plates, gaskets for flange connections and other joints, stuffing box packings of any kind, hangers for piping and cables, grating and chequered plate for stairways and operating platforms, loading facilities, scales, automatic filling machines,

Trucks, tank cars and special vehicles, transport vessels, drums and cans, rubber hose, metal hose—rigid and flexible, erection cranes, self contained portable cranes, welding equipment for gas welding and electric welding, tools of any kind, drinking water supply systems and sanitary facilities, illumination equipment and installation material both explosion-proof and standard design, furnaces, radiators, space heaters, air conditioning plants,

Equipment for the protection of personnel and for the prevention of accidents, timekeeper clocks and recorders, equipment for first aid department, equipment for kitchen and canteens, tools and machine tools, complete equipment for repair shops, complete laboratory facilities, equipment for corrosion protection and lightning protection, fire fighting equipment including small hand sets and large size portable units, painting material.

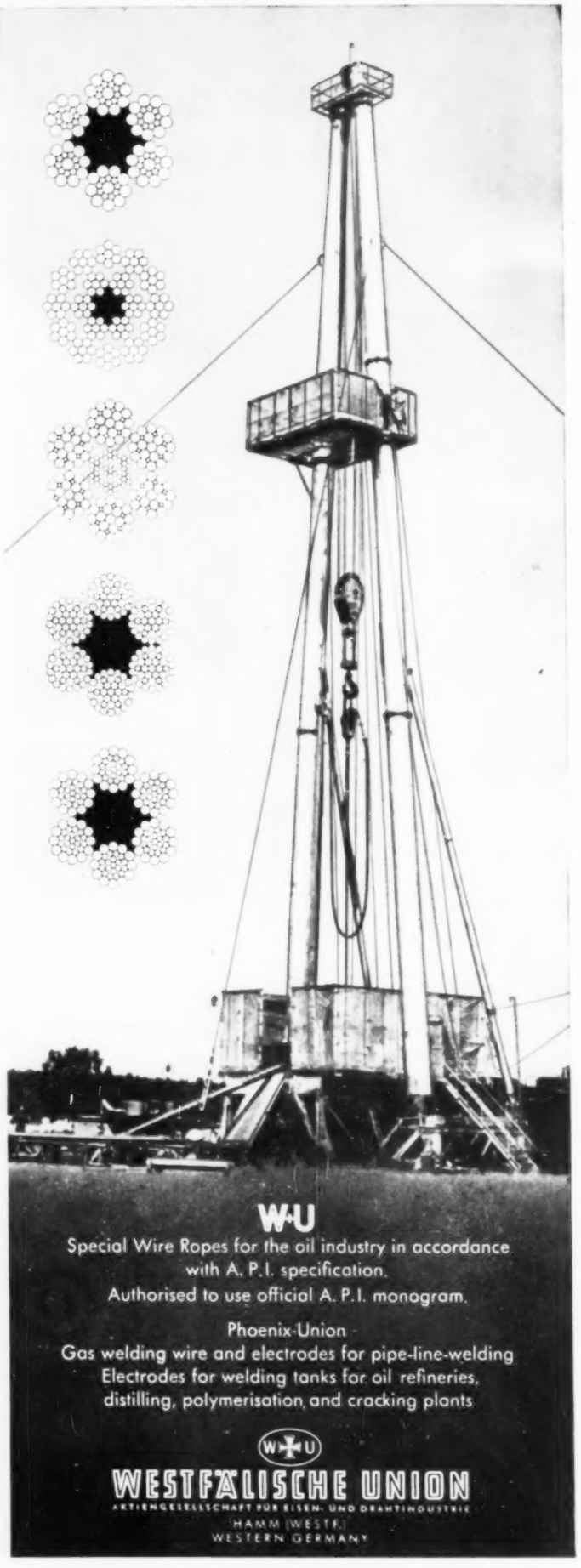
This enumeration is but an extract from the great variety of elements that need consideration in the planning stage of an industrial plant and procurement in good time to ensure an absolutely safe and unobstructed start up after erection. With an actual knowledge of the normal and emergency stocks kept in the spacious warehouses and spare parts stores, it is easy to recognize the amount of such accessories needed even after start up. The warehouses and store rooms are well and carefully organized in every plant so that spare parts may be available for immediate use, if and when required in the event of damages. Substantial expenses are involved, indeed, in the establishment and organization of these facilities, but the funds spent on this item eliminate the much more costly risk of down time and loss of production. In industrialized countries such as Germany the current requirements of mechanical accessories for the construction and maintenance of industrial plants constitutes, therefore, a major item in the domestic economy. There are hundreds of small and big firms which are engaged in the manufacture of such accessories either exclusively or on a sideline basis. Modern workshops, economic manufacturing processes and first class quality are outstanding factors in the services which Germany can offer in all fields included in this broad manufacturing program. Addresses of manufacturers and producers may be obtained at no cost through:

Verein Deutscher Maschinenbau-Anstalten (VDMA)
Düsseldorf-Oberkassel, Luegallee 65

and through

Deutsche Gesellschaft für chemisches Apparatewesen e.V.
DECHEMA
Frankfurt Main, Dechma Haus, Rheingauallee 25

In addition, there are quite a number of German standard buyers' guides which appear regularly each year or at two years' intervals; they are usually printed both in German and English, mostly even in three or four languages, and have proved a valuable help to the export trade.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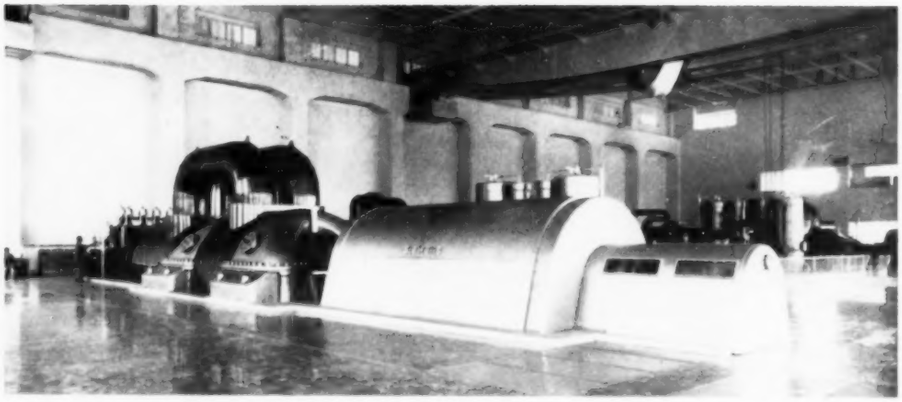
Steam and Gas Turbine Power Stations

By H. G. Waeber, Mannheim



2 Condensing turbine sets of Siemens design with reheat in a power station of the petroleum processing industry, with natural gas-fired boilers, 65 MW, 140 kg/cm² gauge (1,900 psig), 520° C (968° F), 3,000 r.p.m.

In the planning and construction of power stations for the petroleum industry a distinction is generally made between the following three types of applications:

1. Power supply for the opening up and operation of oil fields;
2. Supply of heat and power for the processing plants such as refineries or plants of the petro-chemical industry;
3. Utilization (by combustion or expansion) of the energy content of petroleum and natural gas for the generating of electric power and its supply to the processing industry (chemical plants) or to the public power supply companies.

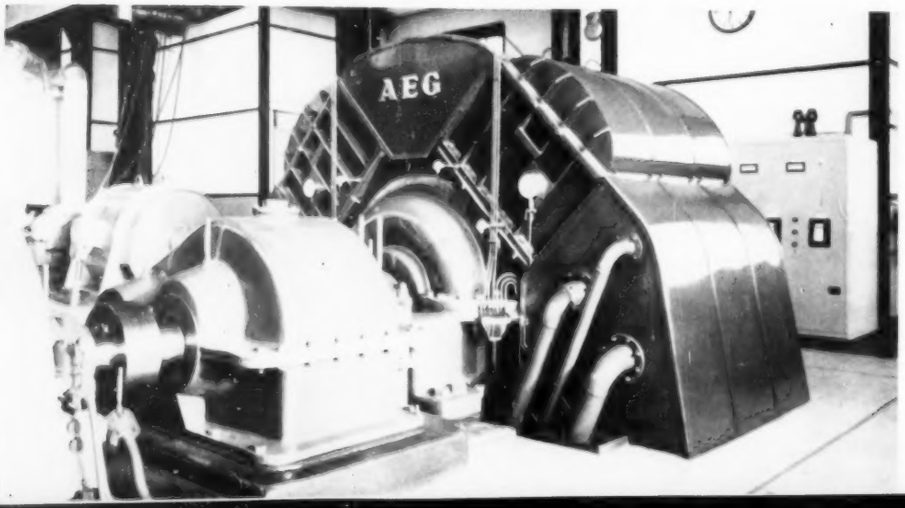
The selection of the proper type of power station depends in the first instance almost exclusively on the power requirements of all installations to be operated in the oil fields and these requirements can be very accurately determined in advance. For power requirements of up to about 4,000 kW, Diesel power plants are very economical, while for still higher loads steam- or gas turbine-driven generating plants are to be preferred.

The economy is based on initial costs, interest charges, consumption of energy (efficiency), service time and running costs. For example, it is uneconomical to operate a steam power station as peak-load station for a short time since this would entail very high running costs. Steam-turbine plants are particularly suitable for base-load operation since, as a result of their continuous running, a high thermal efficiency is obtained. Such conditions are encountered in the various fields of the petroleum industry due to the continuous power demand. The choice whether condensing or back-pressure turbines should be used is governed by the size of the plant and the operating method involved. Plants which require steam for various chemical or physical processes (e.g. refineries) are best provided with back-pressure or extraction turbines.

Gas-turbine power stations offer other advantages. Short starting-up times (with smaller units, 8 to 10 minutes and with larger ones, 15 to 20 minutes) make them particularly suitable for peak-load operation because of their practically immediate availability. The possibility of building gas turbine plants without the need for circulating water opens a wide field of application, e.g. the large oil fields in desert regions. The small space requirements reduce the construction costs, and the simple operation saves operating personnel as the majority of the plants are automatically controlled. The gas turbines have as long a life as the steam turbines and provide the same reliability in operation.

The German electrical industry has at its disposal world-wide experience in the planning and construction of power stations of all types and sizes. Their own supplies include not only the entire electrical equipment of the power station but also all types of prime mover such as:—

Complete steam turbine plants
Complete gas turbine plants
Complete Diesel generating units
All types of back-pressure turbines
All types of extraction back-pressure turbines
All types of extraction condensing turbines
All types of dual-pressure turbines
All types of gas-expansion turbines



AEG compressor, Type LV 305/5, for 40,000 cu.m/h of inlet air, compressed to 5 kg/cm² gauge, driven by a synchronous motor of type S 6720/4, rated 3,000 kW, 6 kV, 50 c/s, 0.9 P.F. lead, 1,500 r.p.m.

Turbo Compressors in the Petroleum Industry

Compressors are employed in a great number of bulk processing methods. They are used where air, gases or vapours have to overcome the pressure losses or flow resistances in the apparatus or where chemical reactions have to take place at a specific high pressure.

The design of the compressor to be employed is determined by the application. The type of construction is governed by the pressure ratio, temperature, capacity and regulating range. Except for the fans which are employed where the total head is comparatively low for near atmospheric conditions, a distinction is made between two particular types, namely centrifugal compressors and the axial-flow compressors.

Uncooled centrifugal compressors are built for inlet volumes from about 3,000 cu.m/h to about 300,000 cu.m/h and for pressure ratios between 1.1 and 4. Water-cooled centrifugal compressors have a delivery volume between 4,000 cu.m/h and 150,000 cu.m/h at pressure ratios between 5 and 10.

Axial-flow compressors are used to ad-

Literature: Carl Brennecke and Rudolf Schinn: "Steam turbines for high steam temperatures and pressures"—VDI Nachrichten 1957, Nos. 24/25/26/27/32. "Gas turbines"—Brown Boveri Mitteilungen 1953, Nos. 5/6.

vantage in installations where the delivery volume is above 70,000 to 100,000 cu.m/h at pressure ratios of up to about 6 (single-casing type). Owing to their comparatively steep-fronted pressure volume characteristic, the axial-flow compressors are particularly suitable for processes which require a near constant volume, independent of the back-pressure.

The pressure ratios can be increased by cascading several units. The overflow pipes are then fitted with intercoolers to improve the efficiency and to reduce the final temperature of the working medium at the outlet branch of the last stage.

The type of construction of the compressor is mainly determined by the composition of the gas to be delivered. Chemically aggressive gases as well as gases with impurities which cause contamination, erosion or corrosion require great care in the selection of the proper material for the impeller and casing, and sometimes even additional equipment, such as filters, separators and preheaters. In no case must the impurities entrained in the gases lead to unexpected breakdowns in operation.

All these tasks and conditions are excellently fulfilled by machines built and supplied by the large German electrical companies.

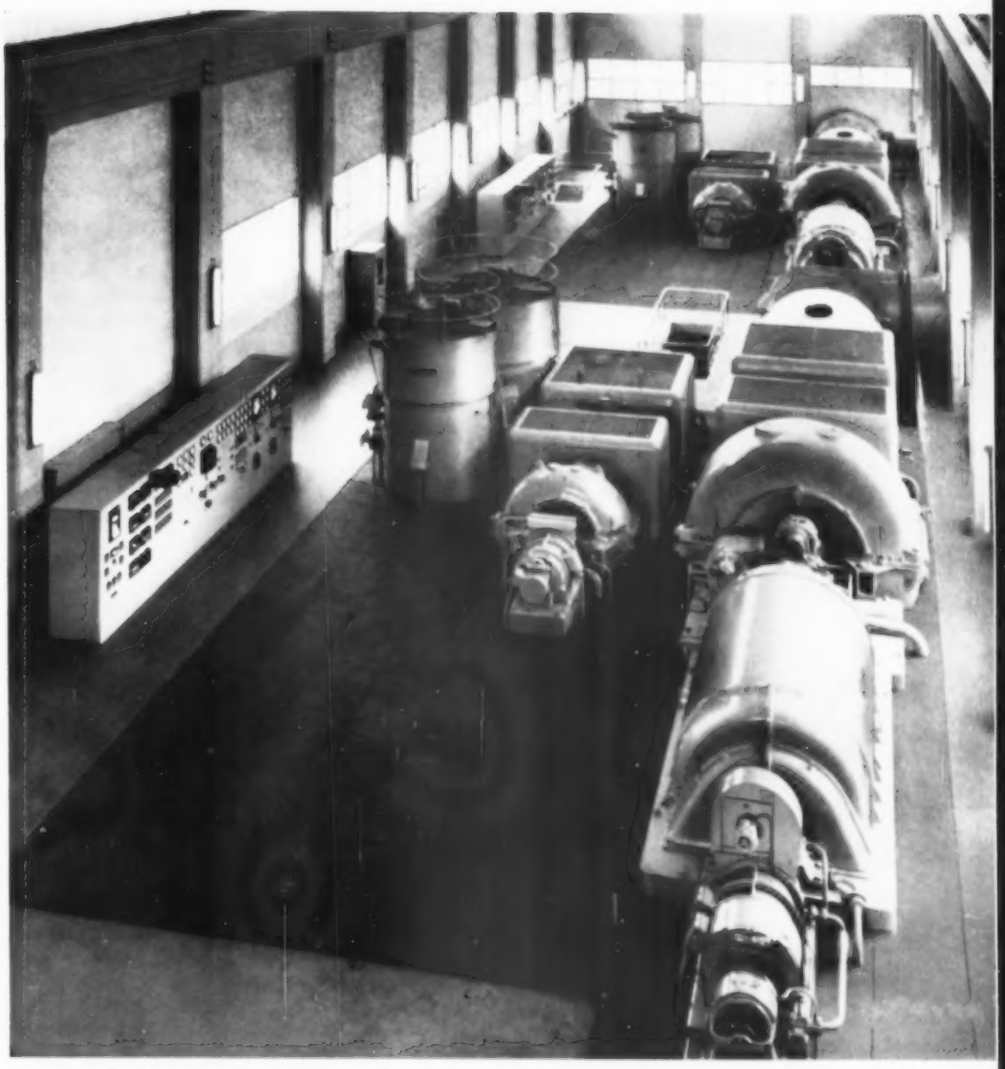
Tankers and Pipelines

In the chain from the extraction of petroleum and natural gas, over the processing to the consumer, conveyance is of great importance. Other requirements are: Safe storage of the inflammable material, continuous supply to the consumers and low costs.

The most important means of conveyance are tankers and pipelines. With the constant increase in consumption these gain ever increasing importance from year to year. This development induced the tanker companies in recent years to use tankers of ever greater tonnage. A great number of tankers of 50,000 dwt and even 100,000 dwt are in the course of construction or on regular runs. Their non-stop service demands a maximum of economy and reliability in operation of the machines.

While most tankers of up to about 10,000 dwt are equipped with supercharged Diesel engines as prime movers, turbo-electric drives are almost exclusively used with large tankers. Low weight high efficiency and superior maneuverability are the outstanding characteristics of modern turbine installations. Whereas steam turbines were mainly used formerly as main drives, they will now have to meet keen competition from gas turbines. As a result of recent developments the atomic reactor, in conjunction with gas turbines or steam turbines, offers new, interesting possibilities. Great importance is also attached to the deck auxiliaries. Nowadays, almost all auxiliaries are completely electrified and thus contribute considerably to the operational reliability of the tankers. Radar, gyro pilot, steering gear, pumps, air conditioning installations, lighting—all of these are electrically powered. Powerful ship's supply system generators, driven by turbines or Diesel, meet the severest requirements.

Closely connected with the operation of tankers are the installations for cargo pumping and discharging. The larger the tanker, the shorter should be the lay time. Powerful handling appliances are therefore just as important for economic operation as high capacity tankers. Special unloading bridges which are often built far into the sea make it possible to unload even the largest tankers within a few hours.



Luigo Orlando gas turbine power station in Livorno, Italy, with two 25 MW gas turbine units. The illustration shows on the left the switchboard, then the combustion chambers, the high pressure and the low pressure unit.

This turbine type is of particular advantage for peak-load and emergency generating stations. Rapid start-up, relatively large unit capacity and minimum operating staff distinguish this type of construction. Brown Boveri has 22 such units in operation or under construction.

For many years it has been the general practice to convey the oil from the oil fields through pipelines. In the countries of destination the crude oil is processed mainly in the ports and transported inland as petrol, Diesel fuel, fuel oil, etc., by tank trucks. The ever-growing demand has now led to the construction of refineries inland and therefore to the construction of pipelines at the consumer end.

Electric drives for the pumps, remote control and telemetering gear contribute essentially towards the efficiency and capacity of the modern pipeline.

Detailed advice by specialized engineers and the supply of high-grade machinery and apparatus by AEG, Brown Boveri and Siemens will prove of the greatest benefit to the customer.

Literature: "Turbo compressors," Brown Boveri Mitteilungen, Nos 5/6 1952. "Industrial application of the axial-flow compressor," Brown Boveri Mitteilungen, No. 11, 1957.

Electrical switchgear

by R. Dehrmann, Frankfurt/M

WHEREVER danger exists for persons working in industrial enterprises the principle of 'safety first' is generally applied all over the world. This principle spread everywhere after having initially been applied in the USA.

The vast plants of the petroleum industry are run under constant risk of explosion, and the same danger exists in the enterprises selling, distributing and consuming petrol and similar fuels. All these enterprises avail themselves of the aid of electrical engineering, and their machines for supply and consumption of electrical energy have to be designed according to the different degree of risk of explosion incurred in the different premises. The risk from operating motors with short-circuited rotors, lighting fixtures, resistors, magnets, measuring instruments, transformers and the like only is due to eventual excessive heating, which might set alight an explosive gas, or mixture of gases and air. The risk from operating switchgear is higher, as even under light load sparks may occur sufficient for firing such gas. This increased risk deserves the special attention given in the following lines. The safety of operation of electrical switchgear calls for one of the three means of protection:—

Flame proof design or 'd' protection
(Druckfest gekaps)
Oil immersed design or 'o' protection
(Olgekapselt)
Forced ventilation of 'f' protection
(Fremdbelüftet)

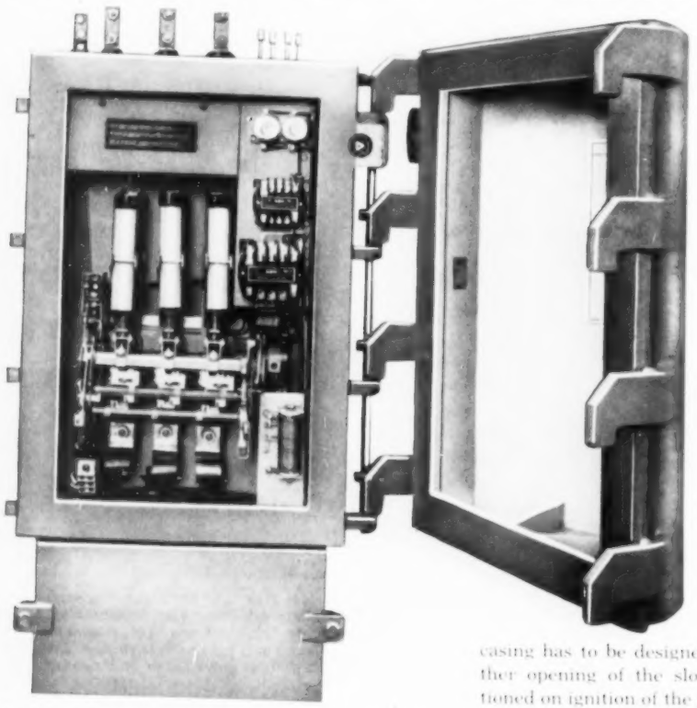
The flame proof 'd' design calls for a casing fully enclosing the switchgear to be protected except for narrow slots in the cover, or outlets for the operating shaft. The casing has to resist the stress from the explosion of eventually penetrated explosive gases. The pressure obtained by such explosion generally does not exceed eight to ten atü (114 to 142 psig). The customary casings of cast iron or welded steel successfully resist the stress incurred by switchgear up to 500 V 1,000 A capacity. The 'd' protected casing has to be designed so as to prevent further opening of the slot or outlet afore mentioned on ignition of the penetrated gas. A safety factor has to be included in the calculation of the design, individual for the concerned gas, and preventing the flash of the inside explosion to the outside. The casings were sealed by a great number of screws located close to each other. The modern design prefers the sealing by breech mechanisms secured by locking bars, sealing strips, tappets or the like against the widening of the slot outlet,—instead of the formerly employed screws. The mechanisms are designed for rapid and easy opening as well as for reliable and fast sealing. They may furthermore be error free designed so as to allow the switching operations, both making and breaking, only when the casing is sealed tight, and preventing any opening of the casing before the switching elements are disconnected from the voltage supply. This means that all accessible parts of the open switch gear are electrically dead; the few part still 'live', e.g. the lead-in connections, are under contact proof cover and wear furthermore warning signs.

The closing by threaded covers is another type of closing employed as its manufacture is easy, and the threads form slots as long and narrow as suitable for the purpose. The afore described flame-proof 'd' design is a reliable protection suitable for L. V. equipment in rooms with permanent risk from explosive gas.

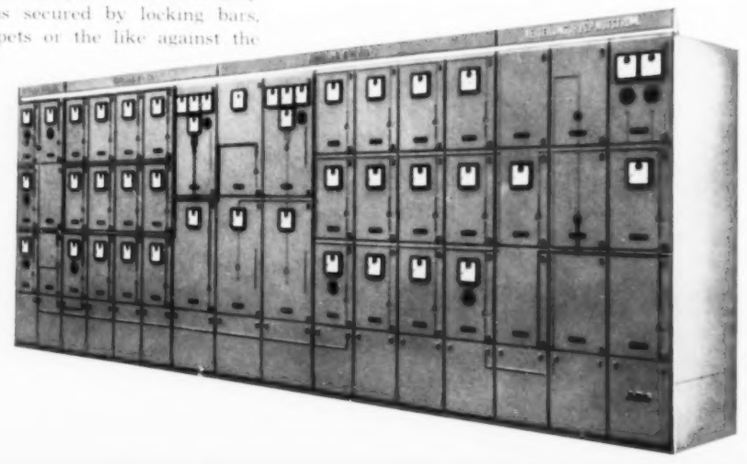
The 'o' protection by oil immersed design is another protection frequently used. The rupturing arc is lit within the protecting oil immersion. It is thus isolated from the dangerous gas above the oil level. The oil quenches the arc, the hot gas developed is on its way up to the surface of the oil cooled down to a temperature not sufficient for firing eventually existing explosive gas. The 'o' protection is highly safe when the switchgear to be protected is properly run and maintained, i.e. if the oil level above the arc developed is constantly kept at the due height. An inspection window has to facilitate the easy and reliable supervision of this level and is provided by the switchgear maker. Its use is an important duty of the operating staff for the switchgear plant. The 'd' protection is recommended for stationary equipment, but not for mobile, as danger may arise from the variation of the height of the oil level on the transport. The proper operation furthermore calls for carefully avoiding overloads destroying the casing. The oil immersion might be set alight.

The 'o' protection is recommended for all units with oil cooling, or with a filling of quenching oil; such are oil breakers, oil immersed starters, oil immersed transformers, oil capacitors and the like. There will mostly be only a small extra cost for increasing the height of the already existing oil level up to the amount necessary for the 'o' protection.

The 'f' protection by forced ventilation provides a constant current of a non-explosive gas, mostly air. This current prevents any explosion at the inside of the gear to be protected, and procures at the outside a reduced temperature insufficient for firing evenually existing ex-



Explosion proof remote-controlled motor switch 500 volts, 100 amps, control voltage 42 volts, in pressure-tight casing with screwless bonnets, upper connection box removed. Photo AEG.



Factory assembled switchgear for three phase current 500 volts, with 2 transformer feeders of 1250 kv each, 1 coupling switch 1500 amps, 3 outgoing cables for circuit breakers 600 amps, 24 outgoing cables with on load disconnecting switches, 2 x 3 panels for emergency current feeding designed for automatic changing over, including measurements of current, voltage, and output of electrical energy. Photo AEG.

plosive gases. The 'f' protection is reliable and economical in many specific cases.

The 'f' protection is on a large scale applied for central protection of buildings, or parts thereof, such as e.g. control or metering rooms within the zones of danger of a plant. There is no individual protection required for all the gear located in a 'f' protected premise and the cost total for such gear is considerably reduced. This reduction will generally over-compensate for the increased cost of the generation and distribution of the compressed air. An over-pressure of about 15 mm water column will frequently be found sufficient.

The recent line of swithgear design comprises patterns without explosion protection, just suitable to be installed in 'f' protected rooms and buildings. There is not only manufacturing cost saved by this design, but also valuable space for erection. New features can consequently be obtained such as compact erection of a considerable number of cubicles within a reduced space, or the application of draw out models of L.V. and H.V. breakers and of two bring-in positions of breakers on undercarriage, e.g. one for the continuous operation and another one for the setting of the remote control under no load. There may be found other new and useful features, such as the direct mounting of additional or auxiliary devices on the undercarriage of the draw out unit; these may be thermal and magnetic quick releases, fuses, timing elements, no voltage circuits etc. The large dimensions of heavy motors for motor generator sets may call for 'f' protection, as the 'd' design here is not feasible. The slip rings of large machines may call for an individual 'f' protection even though the other parts of the machine may be properly protected by another design.

The 'f' protection by forced ventilation will have to be put into operation before the gear to be protected is operated so as to scavenge the space where the gear is located by fresh air. The automatic starting and operating of the forced ventilation will be preferred for convenience, especially as its extra cost also is compensated for by the reduction of the cost total for the gear to be protected, as above described.

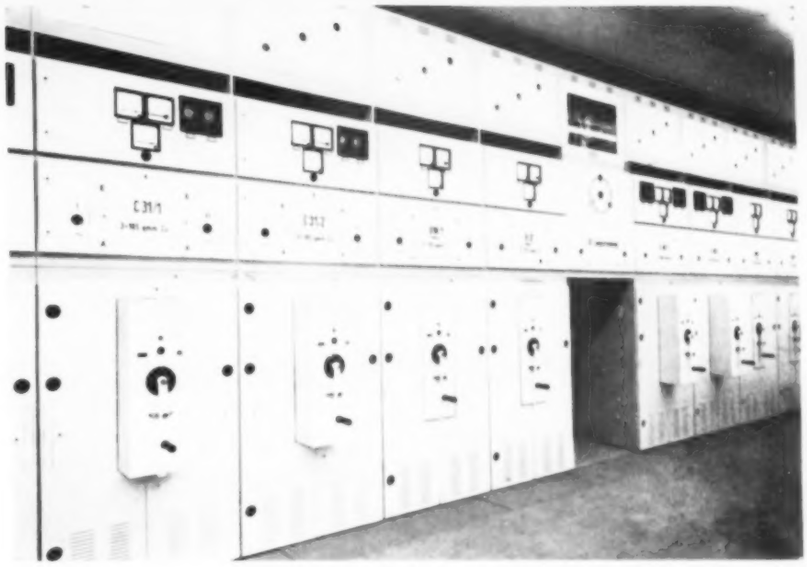
The 'intrinsic safety' is applied for transistorized switching circuits. Transistorized switches are recently used for controlling L.V. switchgear in zones of little danger from points in zones of high danger. The controlling energy is so small that on destruction or short circuiting of the controlling lines no sparking capable of firing explosive gases will occur. Another field of application of the intrinsic safety design are the metering circuits where compensators transmit impressed currents over a wide range independent of resistance and distance met.

Transformers: There are two general categories of design for transformers to be operated in zones with danger of explosion, viz. with filling of oil or clophene; without filling.

The explosion protection of oil or clophene filled transformers is mostly obtained by the 'e' protection, the oil immersed design, and 'o' protection, non sparking design. The protection of transformer without filling is generally obtained by 'd' protection, flame proof design. These designs need here no further comments; please refer to corresponding paragraphs above.

Oil and clophene immersed transformers may be considered as 'o' protected as far as the level of the filling reaches. The other live parts will generally be designed to 'e' protection, non sparking design, which means that the heat developed by the thermal loss of the current flowing is reduced to an amount free from the danger of firing explosive gases. In addition explosion protected temperature-warning devices and explosion protected Buchholz relays will procure the early detection of troubles occurred and will impede damage by leakage of the filling.

Transformers without filling are designed to 'd' protection and need no individual cells made of bricks, an advantage specially valuable for mines. All explosion protected transformers are provided with cable end boxes and their terminals are protected by a special enclosure.



Sheet-steel-clad 20 kV high-voltage switchgear with double busbars and busbar sectionalising. The circuit breakers (400 MVA rupturing capacity) are installed in switch trucks and are protected against faulty operations. This design offers the highest degree of safety and reliability in service and an easy supervision of the equipment and is thus most suitable for the power supply of big industrial plants. Photo Brown Boveri

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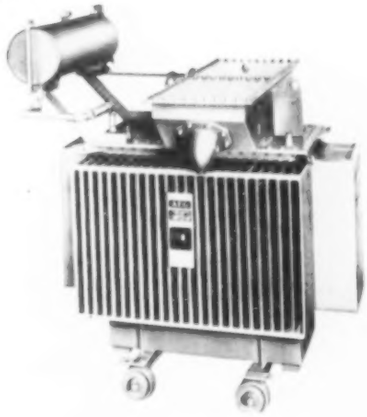
Three-phase oil-immersed transformer type 551/10, rated capacity 250 kVA, series 10, of the explosion-proof type. Photo AEG



Transformer station, made Siemens, with three-phase oil flange-transformer, 1000 kVA, 6/0.4 kV, sheet-steel clad, for outdoor erection, with cable connection box on H.V. side and metal-clad busbar bridge on the L.V. side. Photo Siemens

Rotary Drilling Plants, Drives and Low-voltage Distribution Systems in Oil Refineries

by Simon Oesterlein, Erlangen, Germany

The most commonly used drive in the oil industry is the flameproof three-phase squirrel-cage motor. The motors are built by AEG, BBC and SIEMENS for all conventional output and speed ratings and are designed for **HV and LV** operation. The enclosure of type (Ex) d 2 G 4 is used for motors intended for locations where crude oil or petrol is handled, and enclosure (Ex) d 3a G 4 (Fig. 1) for locations where hydrogen is present in the atmosphere. The motors can be built to German or other Standards.

The housing of the LV motors is made either of steel or of corrosion-resistant cast iron with a particularly high mechanical strength; the HV motors are of welded steel construction. The squirrel-cage motors made by SIEMENS are available in four standard models which are designed to start reliably against load torques equal to 50, 70, 100 and 160% of the rated motor torque.

HV motors with ratings from about 600 kW upwards for compressors are rather expensive if provided with a flameproof enclosure. For such applications, a separately ventilated enclosure can be used to advantage, and the fresh air, for instance, drawn in from the clean atmosphere through a sheet-steel stack. The weather-protected motor (Fig. 2) is another type of large motor suitable for installation outdoors, this, too, being an axially ventilated motor, the air for which is drawn in via a series of baffles which separate the larger dust and water particles before the air reaches the filter.

Fig. 3 shows a BBC squirrel-cage motor, rated 4,300 kW at 125 r.p.m. and 6 kV, for a reciprocating compressor; Fig. 4 shows a synchronous motor built by AEG, 4,000 kW at 4.16 kV, 1,800 r.p.m., designed for hazardous locations, also driving a compressor.

Since class B insulation is used with the motors, they can be promptly re-started after prolonged shutdown periods—as is normally the case with stand-by sets in refineries—without the need for drying the windings.

Protection against overcurrents is normally provided in the form of bimetal relays; on request, thermostats installed in the windings or resistance thermometers embedded in the slots are provided.

The switchgear, too, is available in a variety of designs. If required, flameproof switchgear can be provided and combined in ironclad distribution switchboards (Fig. 3), which are suitable for connection to transformers with current ratings up to 1,000 A. The short-circuit ratings range up to 40 kA. The flameproof casings made by SIEMENS accommodate air-break switchgear with current ratings between 6 and 600 A. The high short-circuit capacity of the motor contactors is obtained through the use of back-up screw-in fuses or fuse links. The contactors are suitable for service at up to 1,500 operating cycles per hour, and since their life is equal to 15 million operating cycles, they form an extremely reliable switchgear item which requires hardly any maintenance.

Fig. 6 shows a flameproof BBC control switch for 15 A. For lighting systems, flameproof transformers up to 20 kVA are available. Lighting distribution boxes are used for distributing the supply over 3, 6 or 9 circuits. Each outgoing circuit is protected by a miniature automatic circuit breaker which is operable from the outside. The protective breakers are installed in flameproof casings of the same design as used for the motor contactors, a feature which makes for a uniform appearance and simple assembly of the protective casings.

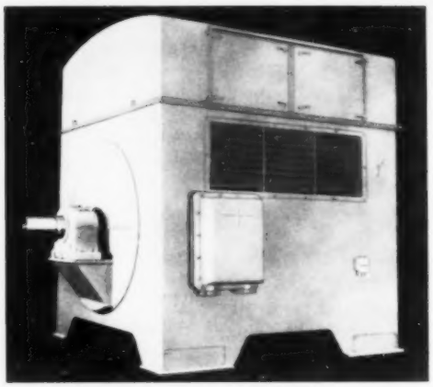


Fig. 2 **SIEMENS** *weather-protected motor for installation outdoors, SIEMENS model, 3,600 kW, 6 kV, 1,500 r.p.m. Works photo:* **SIEMENS**

The units have flameproof enclosures of type (Ex) d 2 G 4 and are manufactured to comply with German and other Standards. Interlocking arrangements on the casings prevent incorrect operation or operation by unauthorized persons.

For the control of drives installed in locations where hydrogen is present, oil-immersed or flameproof momentary-contact control switches with an (Ex) d 3 G 4 enclosure are used.

Metal-clad LV switchboards have been well received for use in substations installed in locations which are not subject to explosion hazards. The switchboards of this type are completely assembled and wired in the works and represent a space-saving and reliable solution (Fig. 7). With the switchboards manufactured by SIEMENS, the individual items of equipment are mounted on easily withdrawable units installed in compartments which are closed on all sides. Doors covering the front side of the units are provided for each circuit and allow the individual items of equipment to be checked for proper functioning. As isolating contacts are provided for the switchgear, the units can be readily exchanged without the need for isolating the bus.

The switchboards have a total height of 2,200 mm (87 in.), and each 600 mm (24 in.) wide panel can accommodate the equipment for up to sixteen 20-A outgoing circuits or eight 50-A circuits. The fact that the individual equipment units for circuits of different ratings can be interchanged makes for simple planning and adaptation to any new operating condition. Automatic circuit breakers up to 3,000 A and air-break contactors up to 400 A are used. The fuses installed make the switchboards suitable for short-circuit currents up to 40 kA. The overcurrent-time protection devices, which can be adjusted between 150 and 500 milliseconds, ensure selective isolation of faulty circuits.

The electrical equipment as supplied by SIEMENS for rotary drilling plants comprises complete three-phase installations with squirrel-cage motors as the drives for pumps, draw works and rotary tables. Speed and torque con-

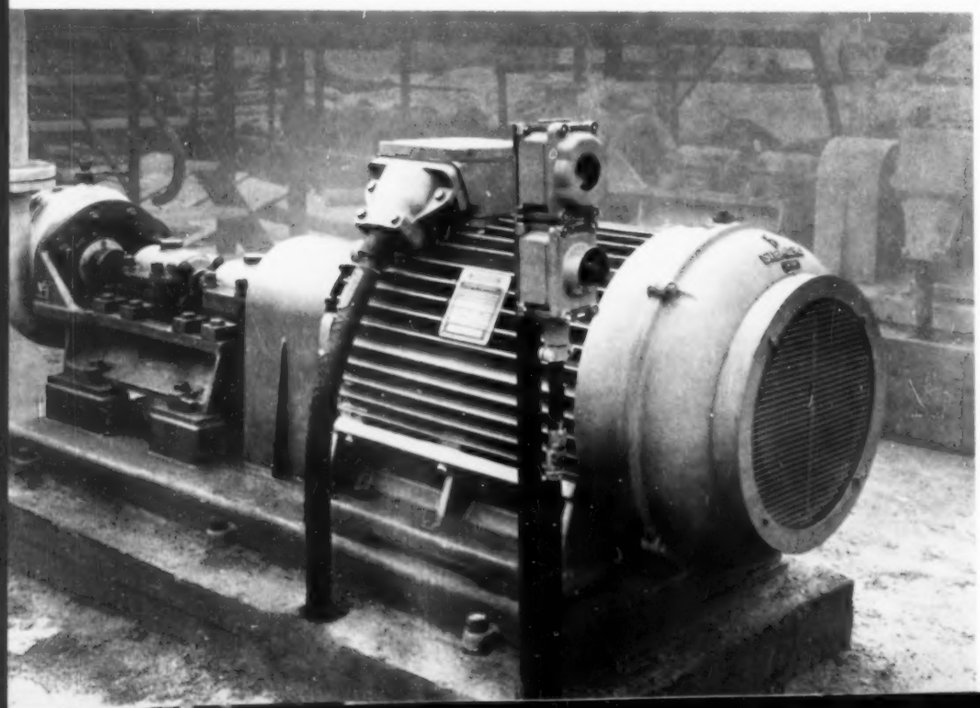


Fig. 1 **SIEMENS** *flameproof LV motor, 76 kW, 3,000 r.p.m., with enclosure (Ex) d 3 G 4, quiet-running design, driving a pump in an oil refinery where hydrogen is present. Works photo:* **SIEMENS**

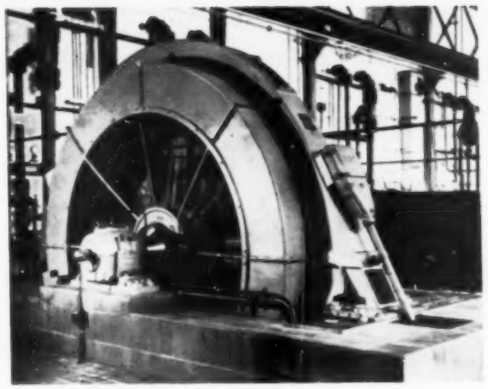


Fig. 3 Squirrel-cage motor, BBC model, 4,300 kW, 125 r.p.m., 6 kV, driving a reciprocating compressor. The motor is self-ventilated and designed for hazardous locations; the stator can be moved on rails on the bedplate to expose the rotor for inspection. Works photo: Brown Boveri

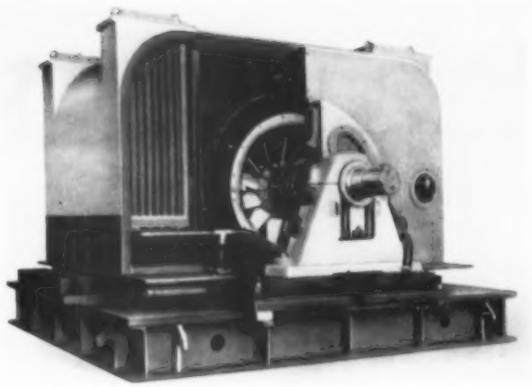


Fig. 4 Synchronous motor, model AEG, designed for hazardous locations, driving a compressor in a refinery in Brazil. 4,000 kW, 4.16 kV, 1300 r.p.m., totally enclosed design, with built-in water coolers. A section of the protective cover is removed to show the interior construction. Works photo: AEG

trol is effected by means of torque converters with adjustable guide vanes. The motors are started direct-on-line and are fed via a common busbar which is installed in totally-enclosed, mobile outdoor switchgear units together with the associated switching, control and supervisory gear. Particularly suitable for the local power supply are constant-voltage generators driven by high-speed Diesel engines. With the load-controlled excitation circuit, the voltage is maintained constant even when the generator operates in conjunction with the draw works. The voltage drop caused by the starting of the large motors driving the pumps and the draw works is balanced within approximately 10 cycles.

The characteristics of the new installation are the simple and clear arrangement, the robust and rugged design of the equipment, easy control and operation, optimum operating reliability, low weight and the ease with which the plant can be transported from one site to the next.

The drilling plant can thus be operated in the most isolated districts or installed on floating drilling islands.

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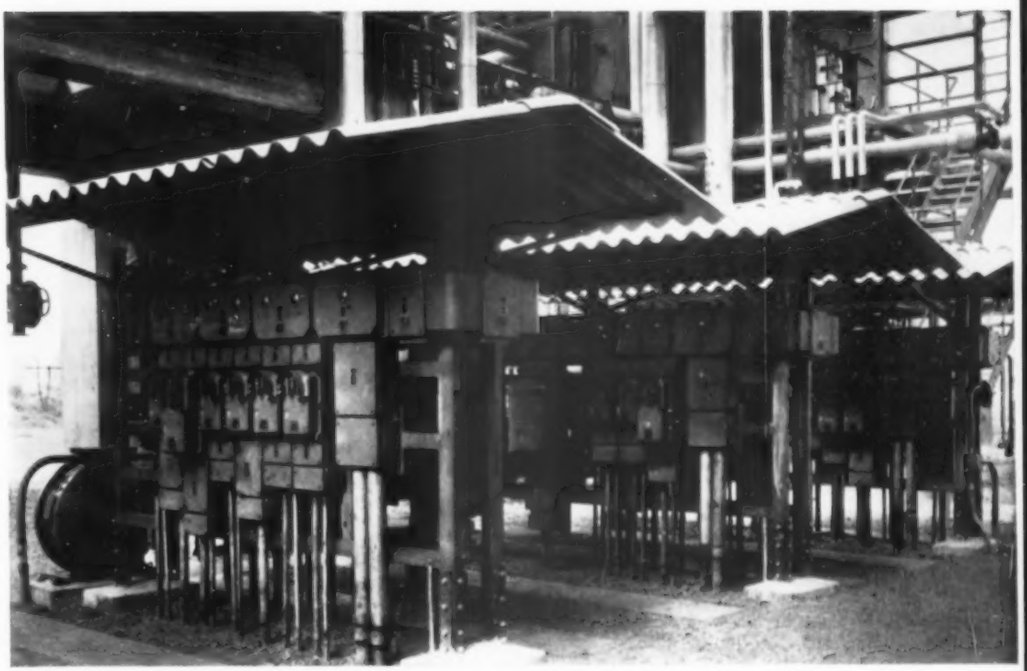

Fig. 5 Flameproof motor control boards, model SIEMENS, with enclosure 1Ex d 2 G 4, installed in an oil refinery; on the left, a flameproof lighting transformer, 20 kV A. Works photo: SIEMENS

Fig. 7 Metal-clad LV switchboard with drawout switchgear, SIEMENS model. Works photo: SIEMENS

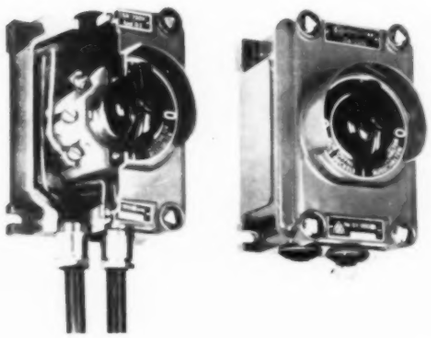

Fig. 6 Flameproof control switch, 15 A, model EBI. The steatite base encloses the contacts, thus forming a flameproof enclosure (Fig. on the left). The outer casing has a particularly high mechanical strength and reliably protects the terminals and the breaker base against accidental contact, dust and water. Works photo: Brown Boveri

SIEMENS

Automatic control equipment of the combined system type for the petroleum industry

THE continual progress of the petroleum industry has led to the erection of many new refineries in Europe. Existing refineries had to be expanded and a widespread supply network to be built up. Because of this, new problems arose in the measurement field and automatic control technology which necessitated new solutions.

For several decades, the house of Siemens & Halske has been engaged in the automatic control and automatic operation of industrial processes. From the beginning, the petroleum industry has been a leader in the development of automatic supervision of chemical and physical processes. The various electrical and pneumatic measuring instruments and automatic control devices which are the outcome of recent findings in modern control technology, have proved their reliability for difficult control problems in European and overseas installations.

The high requirements placed on today's automatic control equipment for industrial processing have led to the development of the combined TELEPERM-TELEPNEU* control system designed by the Measuring Instruments Division of Siemens & Halske AG (Fig. 1). This system which operates with standardized input and output variables is constructed on the building block principle and permits the combination of electrical and pneumatic units in auxiliary power in the form of electrical cur- the control loop. In this way, the advantages of the different control systems operating with rent or compressed air may be attained. The combination provides ease of measurement, telemetering and set-up of complex measuring circuits with electrical systems as well as the speed, reliability and safety of positioning with pneumatic systems.

Electrical TELEPERM instruments operate with direct current. The controlled variables such as temperature, gas composition, pH value, etc., are converted by measuring transducers into proportional "impressed currents" which remain unaffected by resistance changes in the line leading to the controller. With TELEPNEU instruments, however, the controlled variables and the manipulated variables are converted into standardized air pressure variations within the range of 3 to 14 psig.

Electrical as well as pneumatic controllers operate progressively, i.e. they respond much more strongly to high deviations than to low deviations. Thus a steady process operation is obtained under stationary conditions, high dis-

* Trade-mark

Fig. 1 In the new plant of the Measuring Instruments Division of Siemens & Halske AG at Karlsruhe on the Rhine measuring and control equipments for the petroleum industry are manufactured

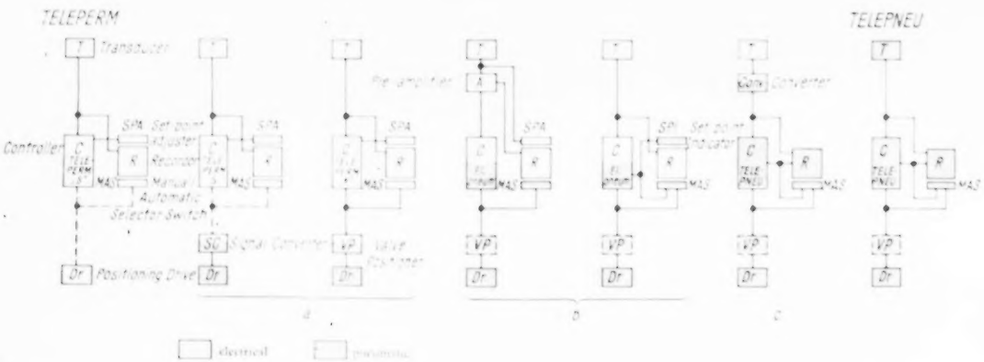

Fig. 2 Schematic diagram of the combined TELEPERM/TELEPNEU System. This standardized control system allows any combination of electrical and pneumatic devices in the control loop

Fig. 1 Semi-automatic testing and calibrating equipment for instruments of the TELEPNEU control system (e.g. pneumatic amplifiers)

turbances being rapidly regulated without the occurrence of oscillations.

The feedback action of the electrical TELEPERM controllers is dimensioned in such a manner that the proportional band as well as the reset time become rapidly smaller with increasing deviations. The final control element is operated by a combined impulse length and impulse frequency modulated controller output. The progressive control of the pneumatic TELEPNEU controllers is obtained by the control action which provides that the rate of change of the manipulated variable is a nonlinear function of the deviation.

For the transition from the electrical to the pneumatic system and vice versa at any point of the control equipment, electro-pneumatic and pneumatic-electrical converters are utilized. Thus, the transition between instruments of different auxiliary power may be performed behind the transducer or transmitter, in the controller, or behind the controller as required by the control problem and the process to be controlled for obtaining an optimum solution.

If the measurement has to be made by electrical means, while the control action and the operation of the final control element has to be pneumatic, an electro-pneumatic converter is interposed between transducer and controller (Fig. 2c). If, however, the transition from electrical to pneumatic operation is to take place within the controller, the deviation may be either formed purely mechanically in the controller (pneumatic set point) or electrically in a measuring circuit (electrical set point), see Fig. 2b.

If the electro-pneumatic transition is effected behind the controller, the impressed current supplied by the TELEPERM controller "K" as output variable has to be transformed by an electro-pneumatic positioner into a proportional position of the final control element.

The TELEPERM controller "K" is specially designed for the combination with a diaphragm motor. In order to utilize in certain cases the advantages of the impulse modulated positioning, characteristic of the TELEPERM controller "S" for pneumatic control, an electro-pneumatic signal converter may be interposed behind the controller the step-by-step operating motor of which actuates a pressure transmitter (Fig. 2a).

With the TELEPNEU system, all variables to be measured, e.g. pressure, flow, level, etc., are transformed, as mentioned above, into the standardized air pressure range of 3 to 14 psig. Thus the controllers are always fed the same input variable which permits the use of the controller for all variables. All other TELEPNEU instruments, such as drives, positioners, computing units, converters, etc., are likewise coordinated to the same pressure range of input and output variables (Fig. 3).

In view of required high accuracy the use is recommended of the force-balance method for all instruments. In principle force-balance instruments have an identical layout although their functions as controllers, positioners, repeaters or converters may differ. They always comprise a reference system, a tap off and a power amplifier and operate according to the balancing method which automatically compensates the output variable against the input. The individual subassemblies are designed as

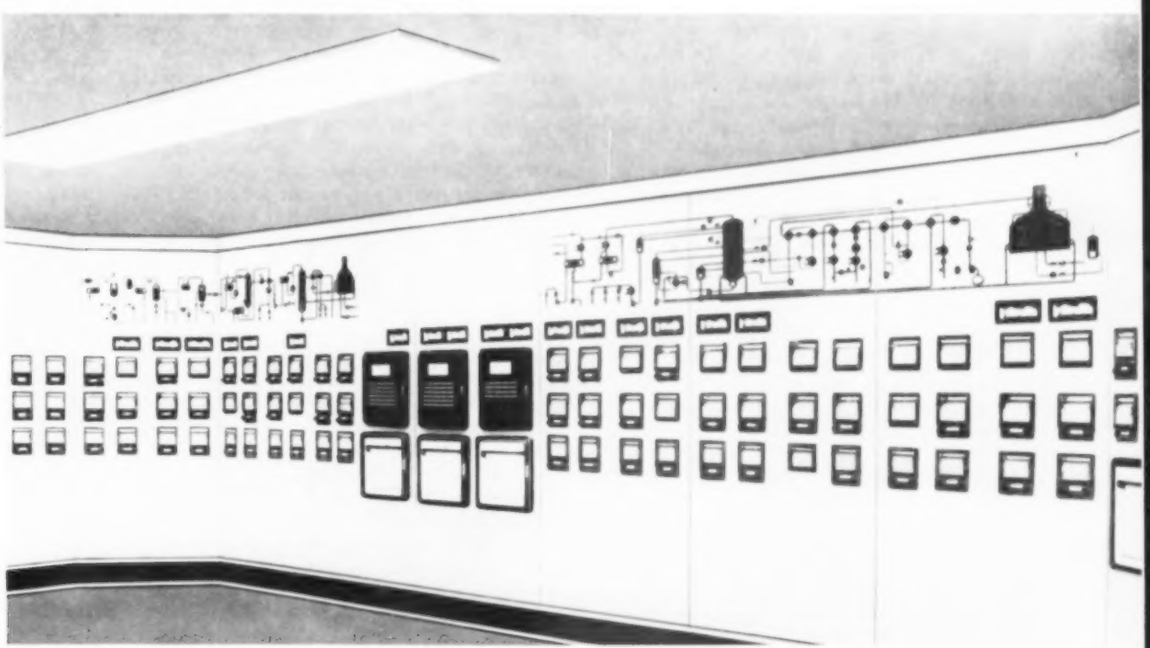

Fig. 4 In modern rooms all potentiometric devices, recorders and indicators required for the measurement and recording of variables are mounted into a clearly designed graphic panel. The photograph gives a view of the control room of a distillation plant.

Fig. 3 Control valve body being machined on the vertical boring and turning mill.

plug-in units and may be interchanged without any recalibration being required. By means of this building block principle, the requirements as to high service dependability, easy maintenance and simple stock keeping are met.

To permit the universal use of combination systems, not only the units for the internal construction of the instruments are designed on the building block principle but also the components of the complete pneumatic control system, such as recorders, controllers, manual automatic control switches, computing relays and transmitters which may work together as required. The recorder may be plugged together with the controller for proportional plus reset action, with the controller for proportional plus reset plus rate action and with the manual automatic control switch to one compact assembly which may be completed by a further plug-in unit, the ratio adjuster, thus forming the TELEPNEU ratio controller. For extremely rapid control processes, especially for the pneumatic flow control of liquids, a special integral action controller for valve mounting is provided.

Due to space limitations, the modern instrumentation of control centers in the petroleum industry makes increasing use of separate instruments for measurement and control instead of the formerly used circular chart recording controllers. The controllers are mounted behind the panel or in the proximity of the final control element. Nowadays, square type instruments are commonly used which permit the construction of clearly designed panels (Fig. 4). Also electrical and pneumatic continuous-line recorders with the square front dimensions of 5⅞ in. x 5⅞ in. and a useful recording width of about 4 in. are now available. The record is visible over a length of 3.5 in., thus permitting operators to observe the trend versus time of the variables over a sufficient period of time. The pneumatic recorders can be equipped with up to three measuring elements, two for recording and one for indicating. The standard design has two elements, one for indicating the set point and the other for recording the actual value of the controlled variable.

For variables measured by electrical means, the line of pneumatic recorders may be complemented by electronic potentiometer recorders which permit recording up to 12 variables in dotted lines. For handling the numerous temperature measuring points in a petroleum industry processing plant potentiometric measuring devices are used which permit selecting up to 90 measuring points by means of noble metal tumbler switches.

Digital measurement has also found application in the petroleum industry. In many cases it is not sufficient to read off and record the measurement or to feed it into the controller but it is often necessary to evaluate the values of variables with high accuracy by data processing to execute computing processes or to release automatic operations. Continually available balance accounts of the produced and consumed material quantities, which must be formed from a plurality of different variables, are also of interest. These measuring data may be stored over extended periods of time or fed into computers and punch card machines as well as printed into tabulations or transmitted by telephone.

The Siemens page-printing teleprinter permits recording up to 25 different 3-digit data per line besides the 4-digit time record. If the measuring points exceed this number, the variables may be printed in several sections of the sheet, the measuring points being selected at adjustable intervals by means of a clockwork or by hand.

During typing, the data may be fed simultaneously into a card puncher connected in parallel or stored as a punched tape which can be used for operating a tape-controlled card puncher. In this way, the data may be further processed on punch card machines.

Telemetering is a further application of digital measurement. Besides the telemetering of pressure and flow values of oil pipelines the pulse code telemetering method is also suitable for the remote control of valves and slides, as performed, for instance, in the first German pipeline from the North Sea to the Rhine.

Due to the versatile manufacturing program of the Siemens Measuring Instruments Division, unexpected contracts of manufacturing procedures will be found when visiting their workshops. The following give a few examples only: In the diaphragm of the Siemens Electron Microscope, made of platinum gold, holes of 0.0008-in. diameter must be bored, the big boring machines in the machine hall, however, are used for making bores having a diameter of up to 4 in. For the manufacture of components watchmaker's lathes are available for 0.012-in. journal diameter as well as vertical boring and turning mills for 40-in. swing (Fig. 5). Light-metal plates having a thickness of 0.0016 in. as well as 0.2 in. thick steel plates are machined. Copper wires are used for making coils of electrical precision instruments, which have a diameter of 0.0008 in. and are thinner than a woman's hair. Wires of 0.08 in. diameter and copper conductors of 1.2 in. diameter are used for current transformers.

The manufacturing program of the Siemens Measuring Instruments Division extends from electrical precision and industrial instruments to complete measuring and control equipment for industrial processing, equipments for the non-destructive testing of materials, and high-resolution electron microscopes.

PROCESS CONTROL

Rationalization and automation of the oil industry present increased demands for improvements in process control.

In most instances, the added expense of monitoring and control systems is repaid by savings within a very short time. This fact explains the steadily increasing portion of capital expended for process control equipment in the erection of new plants.

The increased economy of operation, based on calculation and computation data alone, has resulted in the present-day expenditure for technical equipment and instrumentation. Formerly, the amount spent for process control instruments was related to a fixed portion of the overall investment, instead of giving primary consideration of the possible savings in operating costs. This point of view has become completely obsolete:

The profits yielded by older installations and equipment especially can be increased decisively by the addition of modern control systems.

The HARTMANN & BRAUN AG, Frankfurt/Main (Western Germany) has had many decades of experience in the field of process control, the benefit of which they will gladly make available to you. Their associates, SCHOPPE & FAESER GMBH Minden and HARTMANN & BRAUN-PNEUMATIK GMBH, Stuttgart take part in the production program of operation control instruments. The manufacturing programs of these three firms are combined to produce equipment capable of

Process control – from the points of measurement to the office machine, over any distance, by means of measuring, controlling, monitoring, and recording.

Our products include:

Gas Analysis; Temperature, Pressure, Rate of Flow, Position, Speed

For these and similar tasks, we manufacture pickups, such as thermocouples, standard orifices, etc., as well as force-balance transmitters with pneumatic or electric output (D.C. or A.C.).

The outputs have standard values which are adapted to the measuring, control, and computing instruments. (Ranges for gas analysis: % CO, CO_2, C_nH_m, O_2, H_2, SO_2 and H_2S; for temperature: − 220 C up to + 2000 C for pressure: 20 mm WG up to 14000 p. s. i.)

Our transmitters with Barton cells (US-license) for differential pressure and flow measurements deserve special mention here.

Indicating and Recording

Our electrical and pneumatic indicators and recorders are adapted to the pickups and transmitters. Instruments can be calibrated for the measuring values required. Compact models are obtainable including very small ones (e. g. recorders, 144 x 192 mm for control rooms in installations where space is limited). Special mention must be made of our POLYCOMP potentiometer dotted line recorder for 12 channels, and the potentiometer graphic recorder LINECOMP. Both are instruments of the highest precision. The small pneumatic recorder made by our associates, HARTMANN & BRAUN-PNEUMATIK GMBH, Stuttgart, is of special interest to the oil industry because its design is entirely pneumatic. It contains three measuring systems (three indicators, of which two also record) and one plug-in PID-controller (proportional – integral – derivative), installed according to the building unit principle.

Control

Pneumatic instruments for PI- and PID-control, in the form of plug-in units for use with the small pneumatic controller.

Electric controllers for P-, PI-, PD- and PID-control with D. C. or A. C. input and output are manufactured by our associates, SCHOPPE & FAESER GMBH., which also manufacture the Barton cells described above.

Galvanometric controllers, with their great versatility, are produced by HARTMANN & BRAUN AG.

Careful coordination and adaptation of the production programs of these three firms enable to solve even the most complicated control problems, since the possible combinations involving the various electrical and pneumatic systems, are many and varied, even for very long lines and use under unfavourable operating conditions.

Central Data Handling

Controlling and monitoring a plant from a central point requires a large measuring and control room where the measuring values are available and easy to observe at a glance.

The HARTMANN & BRAUN AG plans and produces complete measuring and control installations with central control rooms, as well as teletransmission equipment for transmitting measuring values. These operate according to the direct current and impulse principles.

Moreover, the instruments of the HARTMANN & BRAUN-CMR-systems for data handling, integration, digital recording by means of electric typewriters represent a continual transition into office machinery technique using punched cards.

Protection against Explosion and Corrosion

All pneumatic instruments are explosion-proof, but special designs are necessary if a protection against explosion is needed for electrical instruments. A great many of electrical instruments may be obtained in explosion-proof design. Protection normally is "intrinsically safe" and in "pressure-resistant casings".

Those parts of the instruments which come into contact with the medium to be measured usually are obtainable in corrosion-proof designs.

HARTMANN & BRAUN AG FRANKFURT/MAIN

M E S S - U N D R E G E L T E C H N I K

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MINDEN IN WESTFALEN

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WERK BESTER STUTTGART-WANGEN

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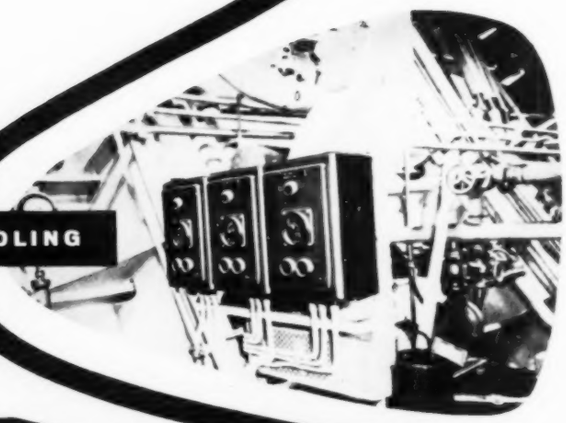
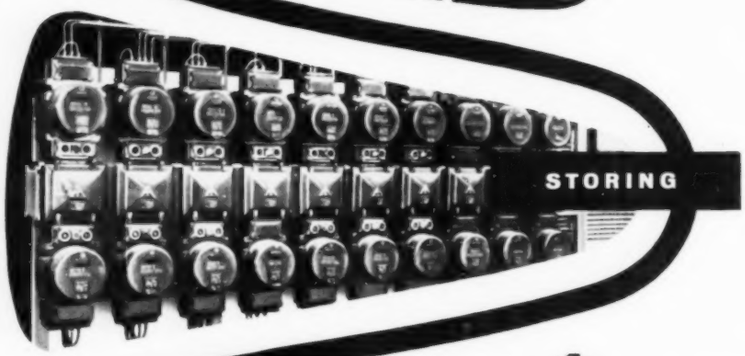
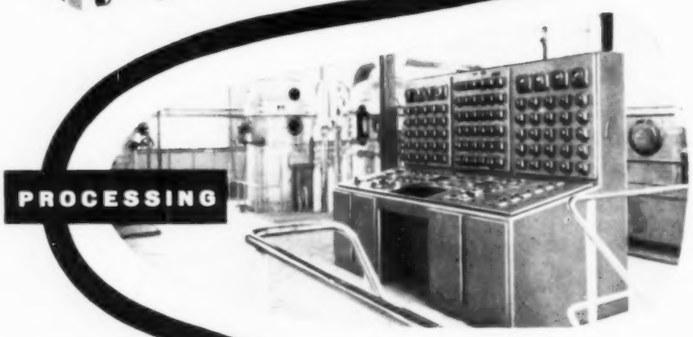
Look where you will in this industry you will be certain to find FANAL switchgear and controls . . . in tankers, pumping stations, tank farms, pipelines, refineries, tank trucks and filling stations. Our production program caters for all requirements and operating conditions. Whatever you need for the control of electrically driven plants . . . from the smallest contact unit right up to a complex electrical control system . . . you can be sure of getting everything from "under one roof" . . . from Metzenauer & Jung.

FANAL low voltage switchgear — in either the standard or explosion resisting versions — is known and recognized throughout the world. It offers plant engineers in the oil industry many advantages, both technical and practical. We will welcome your enquiries. Our planning advice and assistance are yours for the asking.







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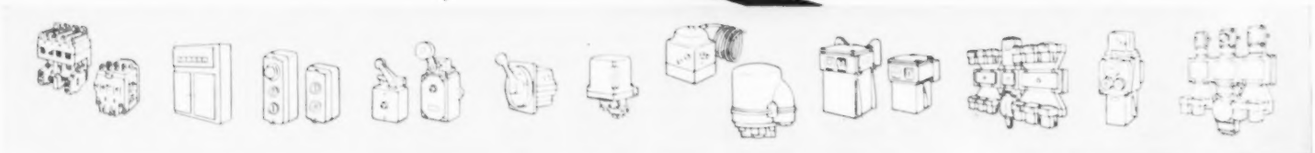

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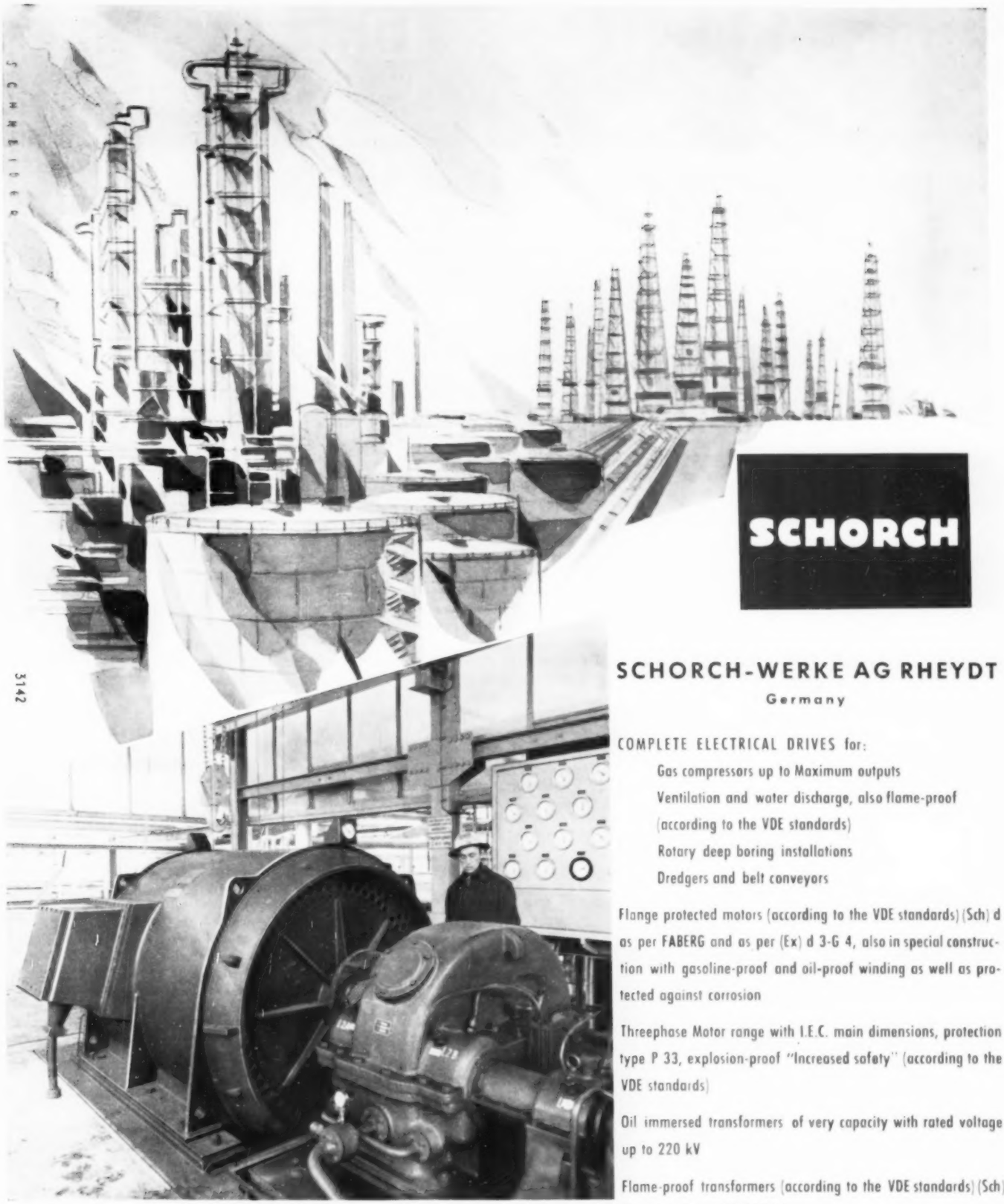

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COMMUNICATION EQUIPMENT FOR PIPELINES

by Dr. H. Carl and Mr. E. Wetzel*

The operation of a modern pipeline system requires the highest possible protection against costly loss of time and damage. For this purpose, a communication system comprising remote control and telemetering is indispensable. It permits quick detection of defects and undelayed action by repair squads apart from facilitating smooth operation under normal conditions.

This paper gives an outline of those groups of communication equipment most suitable for the case of application and introduced in other large-scale operations, of comparable importance. Individual features discussed are telephony, teleprinters, remote control, telemetering and data transmission as well as transmission questions in general.

1. Structural Groups of the Communication System

The communication system for a modern pipeline operation comprises several structural equipment groups which represent the various functions of the overall system. For the sake of convenience, the following four groups representative for the complete system will be considered:

1.1 Transmission Equipment

This is mainly an absolutely reliable group of transmission lines connecting the terminal stations to each other and to oil reservoirs, machine or pumping stations along an oil pipeline. It should provide for a number of telephone and telegraph channels which might be 12 or 60 depending on the service required. Full exploitation of each transmission line should be ensured, for instance, by multiplex telegraphy. The transmission system should transmit all messages and signals orginating from telephony, teleprinter, telemetering and mobile-radio equipment.

1.2 Remote Control and Telemetering

This equipment permits to control, supervise, and measure from one or more central stations, all essential events and procedures throughout the pipeline system, as for instance, positions of valves and shutters, oil flow, temperatures etc. Moreover, this equipment automatically indicates the states prevailing at remote stations and signals trouble alarm.

1.3 Mobile Radio Equipment

Mobile repair squads should be connected by radio to the main transmission equipment at all times. This enables the manager to direct maintenance and repair personnel to points of danger without costly delay.

1.4 Switching Plant for Telephone and Teleprinters

Switching plant adapted in size to the scope of operation must be provided as a means of exchange and interconnection of telephone and teleprinter stations by automatic response to dialing pulses.

2 Considerations Governing the Choice of Equipment

The above four groups of equipment have to fulfill certain specifications in order to be reliable and operative even under adverse operating conditions. Apart from these general requirements, there are special requirements presented by the site, climate, traffic, scope of operations and foreseeable changes. The technical development of the communications industry has found the answers to all cases that might come into consideration for any part of the globe. A few of them will be discussed now, again in relation to the four main groups of equipment defined in Section 1 above.

2.1 Transmission

The transmission lines may consist of ordinary telephone cables; carrier-frequency cables permitting to provide several independent telephone or telegraph connections over one wire; or directional radio links. Construction, reliability and transmission quality of such means have to correspond to the most stringent specifications of intrastate administrations or international authorities. Naturally the cost involved decreases with the length of a connection and with the quality requirements accordingly reduced.

The transmission line will possibly closely follow the pipeline. Repeater stations might be necessary and should be installed at the pumping stations; in fact, the functions of both being similar inasmuch as the "repeater" has to boost the flow of information just as the pump boosts the oil flow.

Local considerations will facilitate the choice of cable or radio transmission. The answer depends on the type of oilpipe used, its length, number of pumping stations, their spacing, and the number of independent transmission paths required for telecommunication.

Generally it may be stated that cables will be more profitable where pumping stations are spaced by not more than 30 km on the average; unless, of course, the costs for cable laying are not prohibitive for some reason. For safety reasons, the cable should have its own ditch separate from that for the oil pipe. A disadvantage of the cable system is the lack of a stand-by transmission line for emergency cases where there is no possibility of switching to a parallel line of a network.

Contrariwise, if radio beams are employed instead of cables unlimited safety of operation can be had with two parallel beams or using appropriate stand-by equipment. In this case, however, the straight-line propagation of radio waves and, on the other hand, terrain obstacles or undulations, may be unfavorable to the co-location of a repeater and a pumping station.

Any desirable number of communication channels, each for the independent transmission of telephone or telegraph messages, can be grouped on a wire line or a radio wave by so-called carrier systems. The carrier equipment suitable for this application is the same as used in nation-wide dialing systems. Fundamentally, this system employs a usually very high frequency, the carrier wave, for the transfer of the energy contained in a number of communication channels, each channel being identified by its own frequency range.

Telegraphy equipment available (VFCT) enables up to 24 different teleprinter messages to be transmitted simultaneously through a single telephone channel.

Hence, the transmission equipment under discussion does not differ, in principles, from modern communication equipment. However, the design of the overall communication system for a pipeline system must of necessity have some special features peculiar to the case of applications.

Generally, the pipeline is several hundred kilometers or miles long. Hence, the associated communication path may be compared with a long-distance connection. However, the conditions affecting the line are by no means as uniform as in telephony of a national network: Every 30 to 50 kilometers, at each branching or pumping station, new channels have to be added to the transmission system. This requires not only special arrangement of the through-switching and branching equipment. As a result most clearly characterizing this case of application, the number of terminal equipments is relatively much higher than might be expected from an even small number of channels.

2.2 Remote Control and Telemetering

For telemetering, all essential parts of a pumping station as shutters, valves, relays, feeler gauges etc. have to be constructed or equipped with converters so that their position or state are marked by open or closed electric contacts. Conversely, for remote

*Standard Elektrik Lorenz Aktiengelsellschaft, Stuttgart - Zuffenhausen, Hellmuth - Hirth - Strasse 42, Germany.

Fig. 1 Example of a remote-control desk with telemetering-signal indication.

control, the said parts should be operable by opening or closing contacts in the remote control station. These additional electric devices are permanently associated with the vital parts of the pipeline system and, moreover, are of identical design as those used for communication equipment and power supplies. As a result, equal conditions prevail at all terminals and connectors, and the units for remote control and telemetering are uniform in function and differing in size only inasmuch as they are adapted, in each case of application, to the number of control functions and measurements required.

The control desks in the central are usually equipped with switches and key senders for remote control as well as with dials, instruments and indicator lamps displaying the state or condition of vital units at the distant pipeline stations for telemetering purposes. A sample is shown in Figure 3. Both remote-control and telemetering signals are nowadays converted in the most profitable form of electric energy before they are fed to the transmission line. A very effective method is the conversion into pulse-code telegrams in which each telegram is identified by its special sequence of pulses and intervals. Separate transmission paths are used for both directions of communication. Whenever two or more pulse-code telegrams are generated at the same time, they are stored for a very short time and transmitted consecutively. Pulse-code telegrams distorted during transmission for some reason, are checked and rejected by an electric circuit designed for this function. They can then be repeated either automatically or manually.

All units of the telemetering and control system are made up of building blocks permitting to expand the system in accordance with growing requirements. These units are mounted on panels assembled in bays or racks, or wall-mounted cabinets.

2.3 Mobile Radio Network

The vehicles of maintenance and repair squads are equipped with mobile transmitters and receivers for various radio frequencies which are so allocated that no mutual interference occurs.

A group of mobile radio stations of this type are linked with a fixed or ground station by radio communication, thus establishing a radiophone loop.

The ground stations are distributed along the pipeline at such spacings as to ensure the undisturbed communication with the mobile stations, taking into account site conditions as well as the line-of-sight propagation of very high frequencies. The antenna of such master station for a group of vehicles, may be mounted on the same mast or tower as the radio-link antenna if a radio link is employed. Although the stationary transmitter and receiver of a ground station can be operated manually, they are designed for remote operation from a central station. For this purpose, they are connected to the central either directly, utilizing the cable or radio link described in Section 2.1, or through a public exchange, depending on local facilities.

Communication with the mobile stations may be accomplished by any one of well-known modes of operation. In the simplest case, the mesage emitted from a stationary transmitter can be heard by all vehicles within a given area provided their receivers are tuned to the same frequency. In some cases, a selective-call system is preferable by which a certain vehicle can be singled out; this vehicle will then be the only one receiving the message. The squads of any two vehicles can communicate with one another either directly or via one or more of the ground stations, depending on the overall distance. Special relay circuits ensure the priority of all calls originated in the central station.

Figure 2 shows the transceiver of a type fitting any car or truck design.

2.4 Telephone and Teleprinter Exchange Equipment

Generally speaking, the same telephone switching plant and telex equipment can be employed as is customary in public networks. This equipment permits direct dialing between all telephone stations or teleprinter operators of the network. Special features are available for any possible requirement. Thus, all teleprinters can be switched to simultaneously reproduce a message from the central. Another important feature is the establishment of a connection with priority, even breaking into existing connections. This feature is indispensable in all industries where every minute lost may run into thousands of dollars in an emergency case.

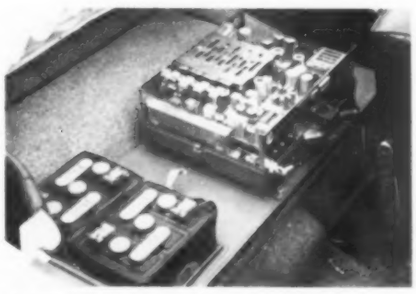

Fig. 2 Mobile radio station for operation in the VHF band.

Fig. 3 Telecommunication exchange combined with control desks of a public utility corporation.

Thus, calls may be roughly divided in private-exchange calls, public-network calls and operations calls applying strictly to the pipeline operations along the whole extension of the latter. An extension station can be so restricted that only calls to other extensions are possible, not, however, to subscribers of the public network or to stations along the pipeline.

For flexible operation of the switching plant with shifting restrictions and priorities, a control desk is available on which various degrees of service can be preset and controlled. Indicator lamps signal the state in which any single line or link is at any instant, and the person in charge may break into existing conversations, listen in, disconnect a connection or connect an extension station to the radio network. Figure 5 shows such a desk combined with remote-control operating facilities.

Details on the systems shown, their modes of operation and cases of application can be found in numerous publications of which some are quoted below:

1. Christ, Laaf and Schmid: Richtfunkanlagen zur Uebertragung von Telefonie und Fernsehen im 4 GHz- und 2-GHz-Band, ETZ-A, vol. 79, no. 19, pp. 687 ff.
2. Schmid: Fernwirkanlagen fuer Elektrizitaets-Versorgungs-Unternehmen, ELEKTRO-WELT no. 10, Nov. 1956, pp. 226 ff.
3. Willrett: Anwahlfernmessung nach dem Impuls-Code-Verfahren, SEG-NACHRICHTEN 1958 no. 1.
4. Haessler: Sonderaufgaben der Nachrichtentechnik fuer Elektrizitaets-Versorgungsunternehmen, VDE-FACHBERICHTE 18 vol. 1954.
5. Matthieu and Schmidt: Neue Fernsprechanlagen mit Koordi-natenschaltern fuer Energieversorgungsunternehmen, SEL-NACHRICHTEN no. 4, 1958, pp. 181 ff.

The chapter "German engineering contributions to the processing of crude oil" in the special issue of the World Petroleum published on the occasion of the world petroleum congress 1959 gives the interested reader a review and cross section of the vast field of activity of the engineering companies and the comprehensive manufacturing program of suppliers to the petroleum and petrochemical industries in Germany. These companies are offering their services and their cooperation for the designing and building of new plants and for the extension and modernization of existing plants throughout the world. The high level and up-to-date status of the German chemical process technology and engineering technique combined with high-grade precision work and rational manufacturing methods justify the confidence of the contractor, engineer and workman to be able to maintain and steadily extend their foreign connections. The industry at large may also in future place its faith in German cooperation and in the articles marked "made in Germany." In return, for this confidence the Germans with their great intellectual, manual and financial potentialities would show their appreciation in the form of active and wholehearted cooperation. This would not only refer to a cooperation in connection with the economic organization of a united Europe but also to the opening of underdeveloped countries and in that way actually contribute to the social and economic satisfaction of mankind. Our German contributions to the steady expansion of the world petroleum industry may be considered as a justification of the confidence placed in Germany; due to its comprehensive influence this world petroleum industry constitutes a decisive factor with regard to the present and future shaping of the standard of living of mankind in peace and liberty.

We have to thank numerous companies and their staff members for placing at our disposal descriptions and photos which enabled us to compile the editorial part of the chapter „German engineering contributions to the processing of crude oil". In the first place we want to thank the Friedrich UHDE GmbH, Dortmund, whose activity made possible the realization of this joint publicity action. In an unselfish way the Friedrich UHDE GmbH, Dortmund, applied their personal and business connections to the benefit of this matter for which we thank in particular the management and the personnel of the publicity department. Moreover, we should like to thank the following companies for their cooperation:

Aerzener Maschinenfabrik GmbH, Aerzen bei Hameln
Babcockwerke, Oberhausen
Maschinenbau AG *Balcke*, Bochum
Bergische Stahlindustrie, Remscheid
Chemiebau Dr. A. Zieren GmbH, Koeln/Rhein
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Stahl- und Roehrenwerk Reisholz GmbH, Duesseldorf
Standardkessel, Duisburg
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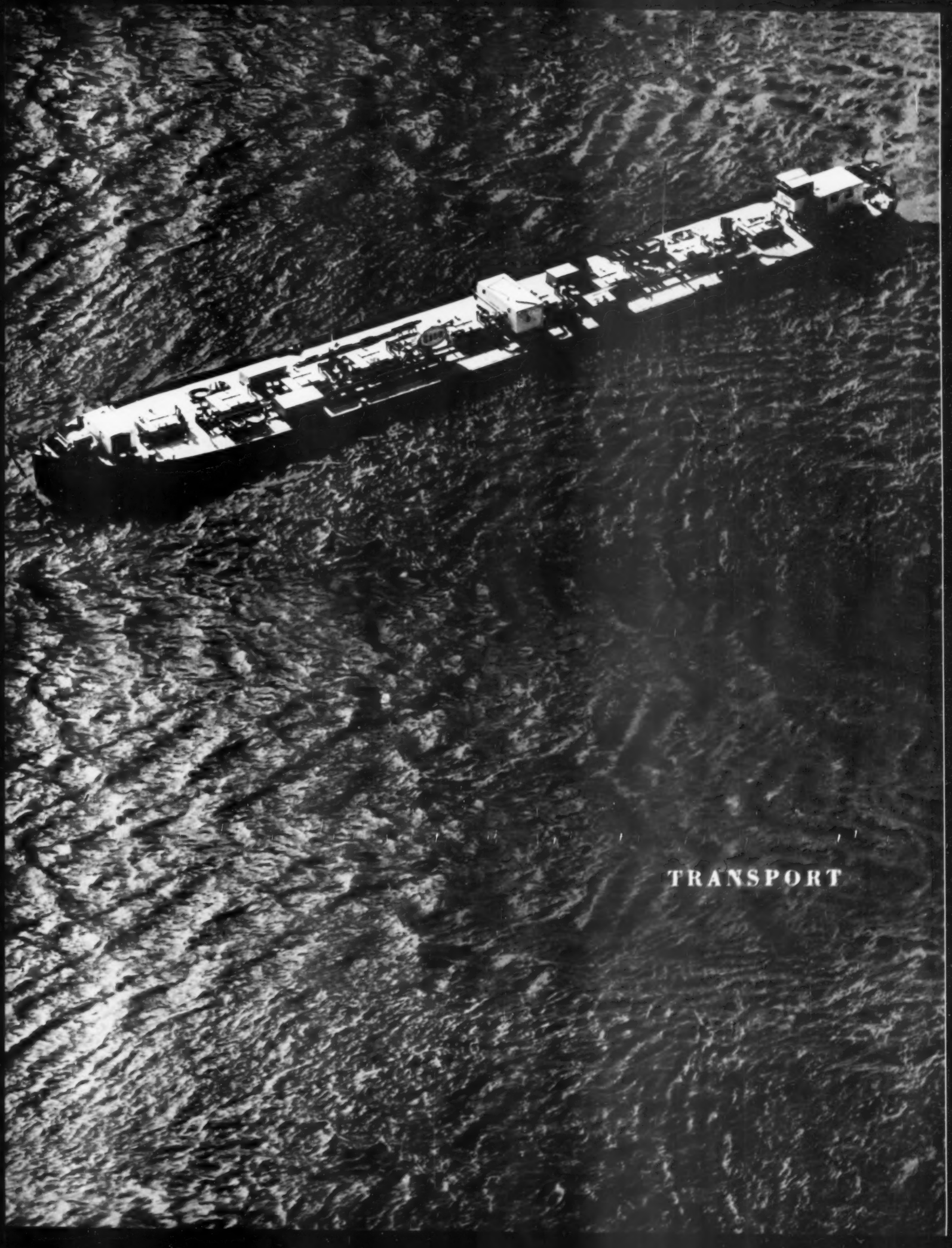


TRANSPORT

Transport of Mineral Oil in the Federal Republic of Germany

by Dr. Ing. Hans Christoph Seebohm, Federal Minister of Transport

With the increasing consumption of petroleum and its many products, the matter of transportation for oil is acquiring increasing importance. For an appreciation of the dimensions of the problem it will be appropriate to give a short sketch of the role that mineral oil is playing in the economic life of the Federal Republic.

Oil Demand Tripled in Seven Years

In recent years demand for oil in the Federal Republic of Germany has steadily increased, as may be seen from these figures, which include refinery tonnage and bunkering (in million tons):

1950	*1951*	*1952*	*1953*	*1954*	*1955*	*1956*	*1957*
5.6	6.7	6.5	7.5	9.6	12.1	15.3	16.5

German Oil Production Has Increased

More than two-thirds of the mineral oil requirements has had to be imported from overseas; the other third is produced in the Republic itself. It is true that, when measured by international standards, the oil resources of the Federal Republic are unimportant, but nevertheless Germany leads all other oil producing countries in western Europe, and between 1950 and 1957 output has increased threefold.

Mineral Oil Production in the Federal Republic
(in million tons)

1939	*1952*	*1954*	*1956*	*1957*	*1958*
1.1	1.8	2.7	3.5	4.0	4.4

70% of the nation's requirement has to be covered by imports.

The figures for these imports are indicated in the following Table:

Years	*1950*	*1951*	*1952*	*1953*	*1954*	*1955*	*1956*	*1957*
Crude oil	2,273	3,474	3,449	4,542	5,974	7,111	7,999	8,158
Finished products	855	632	746	630	940	1,926	3,519	4,232
Including fuel oil	26	120	120	84	418	1,167	1,167	3,058

Oil Demand Will Go On Increasing

The increasing development of the use of mineral oil products will continue in the future. In this connection it must be added that petroleum consumption in the Federal Republic, measured on a per capita basis, still is below that of some other European States. Therefore, the rate of increase of oil consumption in the Federal Republic will probably surpass the corresponding rates of increase of the other countries with higher per capita consumption. According to estimates by OEEC* the domestic consumption of mineral oil will amount, by 1965, to about 32 million tons.

* Organization of European Economic Cooperation.

Refining Capacity Is Currently Increased

These probable requirements present a large task to the petroleum industry of the Federal Republic. It has become of special importance to increase the capacity of the German refineries on a systematic plan. Investments in this field since the war have amounted to about 1.5 billion DM; the result has been to increase refining capacity to many times the pre-war figure.

Refining Capacity of the Federal Republic
(Million Tons at Years' End)

1938	1946	1950	1951	1952	1953	1954	1955	1956	1957
2.5	1.5	5.1	6.1	8.2	9.8	12.6	14.7	14.8	16.6

Rationalization of Transport is a Pressing Necessity

All available data show that mineral oil and its products are quickly becoming an ever more important factor in the field of transport. The network of transport routes and the means of transport have to be continually re-examined because they must be in position to handle increasingly large quantities. It is of special importance to enlarge the capacities of the non-coastal refineries.

A primary concern of the oil companies is to keep the cost of oil transport on the lowest possible level. In view of the great distance oil has to travel from the well-head to the consumer it is undesirable that transport costs figure very large in the total cost. It has been calculated that the average freight charge for a barrel of gasoline is 13%, for a barrel of Diesel oil 21%, and for a barrel of heating oil is as much as 40% of the total cost. These charges are figured on the price per liter, before import duties and other taxes, and the average length of haul in the Federal Republic.

The German Tanker Fleet Is Growing

Measured in terms of the world tanker fleet, the number of tankers under the German flag may seem small. In rebuilding the German commercial fleet a number of tankers have been constructed, but they constitute only 1.4% of the world's tanker fleet. On July 1, 1958, there were under the flag of the Federal Republic a total of about 4 million BRT registered tons; of these, 104 units with 475,000 BRT, i. e. about 12%, were tankers, including three ore/oil tankers.

While the first tankers added to the fleet consisted of purchased old foreign bottoms, more recently newly constructed vessels have become available, whereby the average age of the tanker fleet was lowered.

Within the German tanker fleet are included 24 units with about 340,000 BRT and are in the class of over 10,000 BRT. These ships are being used for the transport of over-sea crude oil to the Federal Re-

public. The remaining 80 tankers are mainly used for the transport of crude oil and finished products in coastal traffic.

Present plans contemplate increasing the tanker fleet by an additional tonnage of about 800,000 BRT before 1963. Making allowance for the scrapping of old tonnage (about 200,000 BRT) this will bring the German tank ship registry up to about 1.1 million BRT by the year 1963.

Future additions to the tanker fleet will be largely in the form of supertankers with capacities of 26,000 tons or more. The decisive factor in this development is that construction and especially operational costs are more advantageous for supertankers than for smaller units. Furthermore, higher speeds render feasible a more profitable employment of the tankers. This shows clearly the continuous effort for rationalization of oil transport.

The Ports Are Being Made Ready to Accommodate the Big Ships

A consequence of the building of supertankers with drafts of 11 and more meters is that the approaches and berths at the ports have to be deepened. Work in this direction has begun:

Crude oil for the refineries of the Federal Republic is unloaded at sea-ports along the Elbe and Weser rivers and at Rhine river ports.

A predominant proportion (50-60 %) is unloaded at Hamburg. These unloadings, in million tons have been as follows:

	1953	*1954*	*1955*	*1956*	*1957*
Elbe ports	2.4	3.8	4.5	4.7	4.5
Weser ports	0.6	0.6	0.8	0.7	0.8
Rhine ports	1.4	1.6	1.8	2.4	2.8
	4.4	6.0	7.1	8.0	8.1

As regards Hamburg, it has become urgently necessary to make this port accessible to super tankers. The Federal Inland Waterways and Shipping Administration has begun deepening the lower Elbe to admit craft with drafts above 11 meters at mean low tide. Arrangements are being made to receive at Hamburg ships with drafts of 11.5 meters at high tide. Further deepening is under consideration. Arrangements are also being made by the Hamburg Port Authority to receive tankers of up to 65,000 tons at Kattwyk-Hafen.

A constant effort is also being made to secure the lower Weser fairway. Here, however, the interest of tank shipping is not so closely affected as in the case of Hamburg. The development of Wilhelmshafen into a great oil receiving port deserves special mention. Here, supertankers will deliver crude oil to Germany's longest and most modern pipeline.

The Jade is being prepared for tankers drawing 12 meters at low water; here stretches of shallow water near Wangerooge are being dredged. Tanker wharfage totaling a length of 1,500 meters is being installed which will accommodate six tankers at a time. It is expected that at first this wharf will be used by 300 tankers a year, and this number will eventually be doubled.

Oil Transport by Pipeline

Where there is the necessity to continuously carry large quantities of mineral oil on certain specified routes, the pipeline is an economic and efficient means of transport. For some time there have been pipelines in the Federal Republic for transporting oil and natural gas, but these have been represented by short lines in the oil fields near Hannover, between Weser and Ems, in the Emsland, and in the Ruhr region. The total length of these lines is about 1,200 kilometers.

The Wilhelmshaven—Rhine Pipeline

The first large pipeline in the Federal Republic connects Wilhelmshafen and the Cologne region. It was dsigned to serve seven refineries in the Ruhr and along the Rhine; these are now under construction or rebuilding. This line is 380 kilometers long, including branches to the refineries, and its diameter is about 71 cm; it terminates in the Cologne district. Only one pump station was needed for an annual flow of nine million tons. It is possible to increase this rate to a maximum of 22 million tons a year, which will require three more pump stations.

Other Pipe Lines in Prospect

In addition to the Wilhelmshafen-Ruhr pipeline, which became operative early in 1959, another pipeline is under way and will connect the Rhine-Ruhr district with the Dutch port of Rotterdam. This line runs from Rotterdam on Dutch territory to Venlo, where it splits; one branch goes to Wesel and connects with an existing line to Gelsenkirchen; the other branch goes to the Cologne district.

These pipelines, which are regarded as the first stage of a planned European pipeline network have a length of 300 kilometers and a diameter of 60 cm. Their initial capacity will be 7.5 million tons of crude oil per year and may later be enlarged.

320,000 Tons of Interior Tanker Capacity

For transport of mineral oil and finished products on interior waterways there is a considerable fleet of small tankers available. At present the whole fleet of inland craft in the Federal Republic can carry about 4.4 million tons. This includes about 320,000 tons of motor-tankers and tank-barges, amounting to about 8% of the total. In addition to German-owned tankage there are a number of foreign bottoms which are of essential importance mainly for transport on the Rhine; particulars of this tankage are shown in the table below.

The Tank Fleet on the Rhine
(as of Jan. 1, 1957)

	Motor Ships		Barges	
Country	*Number*	*Capacity*	*Number*	*Capacity, Tons*
Federal Republic	119	79,393	37	32,635
Netherlands	154	112,292	103	121,620
Belgium	8	5,526	2	1,825
France	3	2,548	13	13,071
Switzerland	63	54,612	10	11,801
Totals	347	254,371	165	180,952

Fourfold Increase in Transport on Inland Tankers

The volume of oil transport quadrupled between 1950 and 1957.

Mineral Oil Transport on Interior Waterways of the Federal Republic
(in million tons)

1936	*1950*	*1954*	*1955*	*1956*	*1957*
2.9	3.4	7.5	9.1	11.3	13.2

In recent years the transport of mineral oil on the inland German

The Esso Guildford

waterways was only 2.9% of the total volume of goods carried in 1936; it rose to 8.3% in 1956 and to 9.3% in 1957.

Tank Farms on the Inland Waterways

Along the rivers and canals within the Federal Republic German oil companies have erected a number of tank farms for oil storage from which the whole Federal territory may be continuously supplied with petroleum products. Since 1945 these firms have made large investments in such facilities, and are still enlarging them.

Railway Tank Cars Take Care of Individual Needs

Railway tank cars are indispensable for transport service between refiner and consumer. Of course, though their capacities (from 10 to 45 tons) do not compare with the capacities of the water-borne carriers, they have large usefulness in serving users and distributors.

Two thirds of all the private cars that carry freight on the Federal Railways are oil tank cars; 60% of these are vehicles that carry petroleum products and belong to the "Vereinigte Tanklager- und Transportmittel GmbH (VTG)," 23% are operated by the oil companies, and the rest by small operators. The number of specially built vehicles for petrochemical products and compressed gases is increasing year by year.

Mineral Oil Transport on the Federal Railways

(Million of tons)

1950	1951	1952	1953	1954	1955	1956	1957
7.1	7.9	8.1	8.7	9.7	10.7	11.9	11.5

For deliveries from tank farms to their local distributing points the oil companies have a fleet of supertrucks totaling 1,524 units as of July 1, 1958, plus 2,154 trailers. No statistics on the volume of mineral oil that is carried over the highways are available.

Conclusion

As fuel for combustion engines, petroleum has been the major factor in the development of the transport system without which our employment-creating economy could not be conceived. On the other hand oil itself in its character of a commodity to be transported is of growing importance.

In recent years we in the Federal Republic of Germany have seen how the use of mineral oil has been extended into many new fields which in turn has created a rapidly increasing need for petroleum. We must, therefore, see to it that this growing need must be sufficiently covered, and from the standpoint of the general economy it must be covered under the least expensive cost for transportation.

Besides the increased need for expanding the capacity of the means of transport which is imposed by the rising consumption of mineral oil, there is also the need for ensuring the rational use of this oil. The German economy can be expected to take care of both developments as time goes on.

Modern tank ship unloading installations in the Mediterranean

by Dr. Ing. B. Zapp, Mannesmann Aktienzesellschatt, Dusseldorf, and Dr. Ing. K. H. Seegers, Rheinstahl, Hamburg

Two Italian oil refineries were recently equipped with novel big tanker unloading installations in the form of artificial islands erected off the coasts of Northern Italy and Sicily. Projects of this kind are now also in demand in other countries due to changes in the capacity of tank ships, and depending on local conditions, the solution of such problems varies widely both in layout and design. The installations described here are new unloading facilities, built for the first time in the form of artificial islands for refineries at Ravenna and Augusta, Italy.

1. The Ravenna (Adriatic Sea) Plant.

The City of Ravenna, once an important Adriatic port in antiquity, has now withdrawn from the coast due to the erosive activity of the Po River and is only accessible for smaller sea-going vessels by means of a canal. This made it necessary for Ravenna's SAROM refinery to create suitable loading and unloading facilities for the steadily increasing tank ship capacity. Originally, an island mounted on tubular steel piles was planned about three miles off-shore, and this island was to be accessible for vessels up to 32,000 dwt. Since, however, the first tankers with a still greater capacity were built during the planning period, it was resolved to move the island farther out into the deep-water area. It was finally erected at an off-shore distance of approximately four miles. At such a distance, it was not considered advisable to moor a vessel right alongside the unloading site, but to provide a safety distance of up to 22 yds. between the island and the ship. The vessels were to berth on buoys alongside the dolphins as far as weather conditions permitted. They could also be positioned so that their sterns faced the island to enable them to cast off quickly when rough weather called for a speedy departure. Experience during the initial operation period showed that most tanker skippers preferred this latter method. The islet is 49 ft. in diameter and equipped with two superimposed structural steel platforms with a slewing crane fixed in between.

Connection to the mainland was established by means of four submerged pipelines; one 16-inch line for unloading crude oil and loading bunker oil, two 8-inch lines for unloading and loading kerosine and gas oil, and another 8-inch line for loading gasoline.

These pipelines are provided with hose adaptors to connect four 8-inch hoses simultaneously. However, operation pressures of 228 psi and 142 psi were prescribed for the crude oil and other hose respectively, since operation and control conditions are favorable.

The hoses are arranged so that the crane can cover an area of 300 degrees around its pivot axis.

Slewing Crane Specification

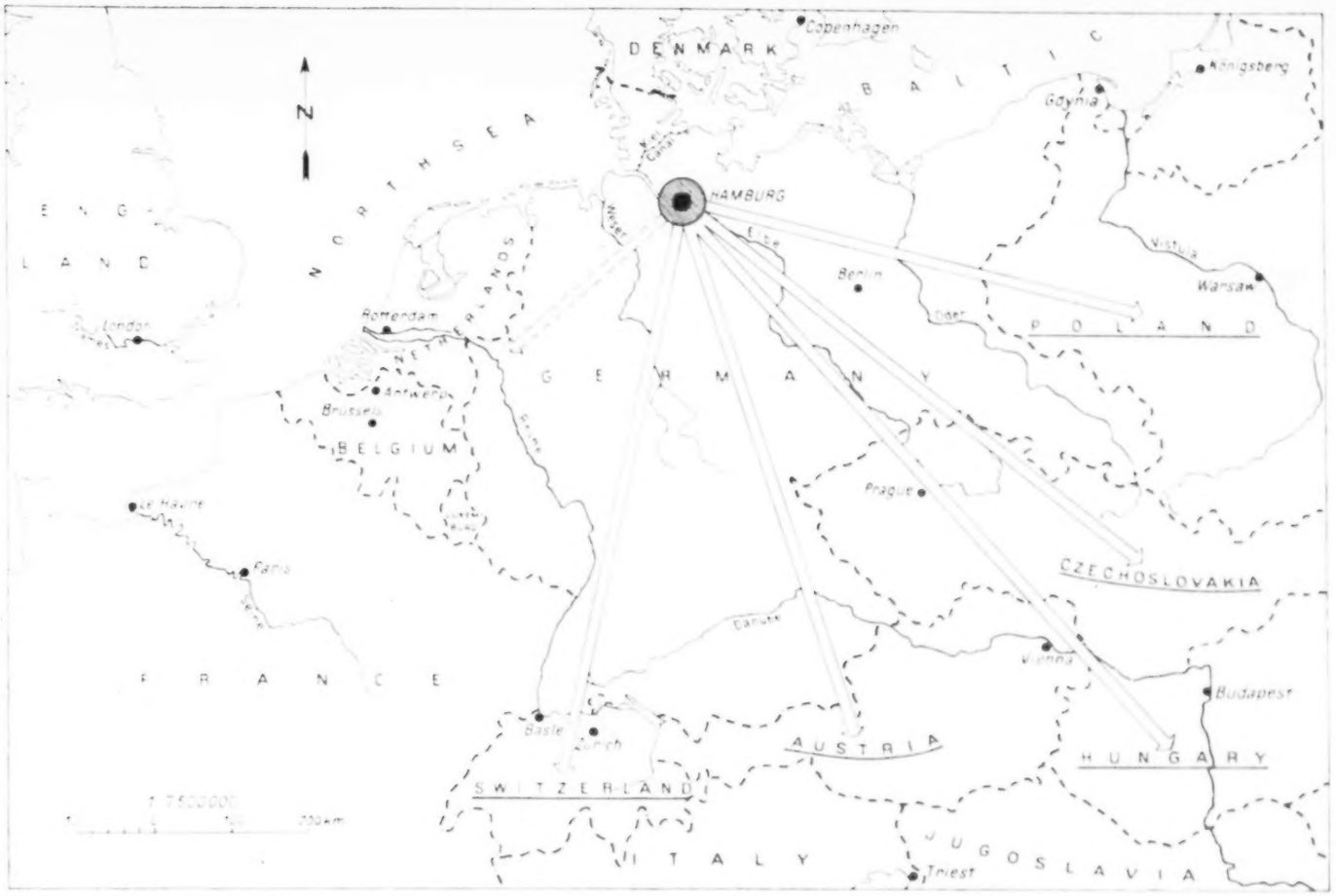
A. *General.* An electrically driven derrick crane serves to carry the hoses over to the tank ships and hold them during pumping. A main jib, retractable from 10° to 60° inclination, is fixed on the crane pivot column.

An auxiliary jib is also provided which is freely movable about 180 degrees to one side in relation to the main jib and the crane pivot column and, like the main jib, retractable from 10° to 60° inclination.

A tubular mast, 85 ft. high, is rigidly fixed inside the hollow pivot column and carries an arrangement of navigation signals. Each of the four oil hoses suspended from the main jib and each of the two oil hoses reaching from the second jib to the tank ship is held by two electric hoists. Thus each hose can be given any individual curvature required by the ship's freeboard and distance from the island within a range of 16-49 ft. Hereby it was also taken into account that the tanker's hose connections may be located at a distance of up to 16 ft. from the ship's side.

Besides the electric hoists for hose adjustment, another electric hoist is provided on the main jib and serves to exchange the hoses. The hoists are arranged collectively at the pivot column base or at the lower ends of the jibs. They are positioned so that each rope runs freely and all mechanisms are easily accessible.

(Continued on page 277)



Hamburg, Germany's oil port

Hamburg's Importance for the mineral oil supply of West Germany

Oil consumption has grown steadily in the Federal Republic just as in the rest of the world. The largest consumers and those responsible for this development are motorized traffic industrial users of fuel oil, public utility companies, shipping, and the petrochemical industry using it as a basic raw material. As a source of fuel for space heating in houses and other buildings oil is gaining in importance from day to day because of its advantageous qualities of easy manipulation, high heating value, and low storage space requirements. No wonder that the consumption of oil and its derivatives has grown from 5.6 to 19.5 million tons during the years 1950 to 1958. For the future we may expect a further increase, particularly since the oil consumption in the Federal Republic lags behind other European countries and the United States of America. The rise in consumption of fuel oil has been most remarkable during the last few years and is reflected in the output of the refineries and its share in the overall imports.

Oil Consumption in the Federal Republic
(millions of metric tons)

Year	1950	1951	1952	1953	1954	1955	1956	1957	1958
Total oil	5.6	5.7	6.5	7.5	9.6	12.1	15.3	16.6	19.5
Fuel oil	0.2	0.8	0.8	1.0	1.2	2.1	3.8	4.9	7.5

Though the Federal Republic ranks first among the oil producing countries of West Europe, the actual output of domestic crude oil is small compared with that of countries in other continents. However, it may be regarded as reasonably satisfactory that 25-30% of German requirements are met from indigenous wells. In view of the rapidly increasing consumption this domestic share tends to decrease despite growing output. It is evident, therefore, that the Federal Republic is highly dependent on imports of mineral oil. Roughly two thirds to three fourths of its overall requirements must be imported.

Indigenous Output and Imports of Oil by the Federal Republic

Year	1950	1951	1952	1953	1954	1955	1956	1957	1958
Indigenous output	1.1	1.4	1.8	2.2	2.7	3.1	3.5	4.0	4.4
Imports	3.1	4.1	4.2	5.2	6.9	9.0	11.5	12.4	15.7
Total	4.2	5.5	6.0	7.4	9.6	12.1	15.0	16.4	20.1
of which fuel oil imports	—	0.1	0.1	0.1	0.4	1.2	2.4	3.1	4.4

Before the second world war imports were mainly derivatives. Since 1945 a fundamental change has taken place in the composition of German imports. The international oil companies have built refineries on a large scale at consuming centers and this has led to the imports consisting mainly of crude. When searching for an appropriate location for plants these companies were soon inclined to accept the many advantages offered by the great sea ports where, in any case, the oil had to be transferred from sea-going tankers into other means of transport. And thus it happened that large refineries were located and built in Hamburg and Rotterdam. Only a few years ago two-thirds of West German refining capacity was in Northwest Germany. In the meantime other districts have also become attractive and refineries have been built, or are being erected, on the Rhine and in the Ruhr in close proximity to an even larger, consuming area. However, these plants have to accept the disadvantage of double handling of their imports using for inland transport either water craft or, quite recently, pipelines. In this connection it may be mentioned that at the main German oil fields (Lower Saxony, Emsland and Schleswig-Holstein) refineries also have been built.

Refining Capacity in the Federal Republic
(millions of metric tons)

Year	1950	1951	1952	1953	1954	1955	1956	1957	1958
Total	5.1	6.1	8.2	9.8	12.6	14.7	14.8	16.6	21.2
Elbe region	1.6	1.6	1.6	2.3	4.0	4.6	4.6	5.5	7.5

Corresponding with the location of the two main consuming areas oil imports of the Federal Republic find their way mainly via the river Elbe and the Rhine. Imports via the Elbe are by far the most important, and Hamburg, therefore, has rightly been called the oil port of Germany. Since early 1959 Wilhelmshaven has stepped into the picture as a new oil port, a pipeline having been built to connect it with the Rhine/Ruhr district.

Routes of Crude Imports into the Federal Republic
(millions of metric tons)

Year	1950	1951	1952	1953	1954	1955	1956	1957	1958
Elbe	1.4	1.9	2.2	2.4	3.8	4.5	4.7	4.5	5.8
Weser	0.2	0.5	0.5	0.6	0.6	0.8	0.9	0.8	1.1
Rhine	0.7	1.1	0.7	1.5	1.6	1.8	2.4	2.9	3.8
Total	2.3	3.5	3.4	4.5	6.0	7.1	8.0	8.2	10.7

As mentioned above, originally only petroleum derivatives were imported via Hamburg, and it was as recently as 1934 that the first refinery of "Eurotank", since 1948 incorporated in the BP refinery, was established at the new petroleum harbor in Waltershof, within the port district. Other refineries followed up to 1938, such as that of the DEA in Wilhelmsburg and SHELL in Hamburg. In addition, a number of plants for second-stage distillation were erected within the Hamburg port area. During the war these installations were a special target of many air raids. Buildings, machinery and equipment were hit, built and again destroyed, leaving nothing but an enormous heap of rubble and twisted steel at the end of the war.

However, very soon after 1945 the reconstruction of these plants was taken in hand on modern lines developing more extensively than ever. Other companies built new refining capacity. About 495 acres of new land in the port district have been developed for this purpose since 1945. Outside the post district other facilities on the Elbe for handling and storing oil are maintained at Brunsbuttelkoog (Kiel Canal) and at Stadersand, about two thirds of the way up the river to Hamburg.

Capacity and Throughput of Hamburg's Refineries
(millions of metric tons)

Year	1950	1951	1952	1953	1954	1955	1956	1957	1958
Capacity	1.6	1.6	1.6	2.3	4.0	4.6	4.6	5.5	7.5
Throughput	1.6	1.6	1.6	2.3	4.0	4.6	4.6	5.0	5.4

B. Hamburg's Advantages as an Oil Port

The Port of Hamburg is the most easterly of the great ports on the North Sea. It is located farthest inland. The river Elbe allows the largest sea-going vessels to travel upstream some 70 miles into the port which may well be called one of the great gateways to Central Europe. All important towns and industrial centers in the Elbe and Danube basins are situated within the port's natural zone of influence and an extensive and modern network of railway, road and inland water connections links the port with its far flung hinterland. If, today, the exchange of goods in certain directions is still hampered by political restrictions, the port is confident that sooner or later the natural forces of attraction will again assert themselves to their full extent. And that will be the time when Hamburg's position as a transfer point in the commercial intercourse between countries overseas and Central Europe, between East and West, will again become effective.

Today, nevertheless, the Hamburg region offers significant advantages for a concentration of the oil industry. In the first place the large tanker carrying oil from overseas is able to discharge her load immediately at the refinery. All double handling involving high extra costs is eliminated and, in addition, the low transportation cost by sea-going tonnage (roughly one tenth of the cost of inland water transport) is fully effective right up to the point of consumption, ensuring a particularly low-cost crude supply. In view of the growing demand for oil and petroleum products this feature gains in importance since cost of transportation in the overall production costs is extremely high (13% for gasoline; 21% for Diesel oil; 40% for fuel oil).

Equally significant is the presence of a highly developed consumer concentration with a wealth of industries and public utility companies. Hamburg is not only the largest city in the Federal Republic but at the same time its largest industrial center. The increasing consumption of fuel oil by Hamburg's industry opens especially favorable vistas for Hamburg's oil industry. Furthermore, its port as one of the world's largest terminals for shipping has a large demand for oil bunkers.

In cooperation with the Federal Authorities the Hamburg Senate, the City-State's Government, is making a great effort to safeguard the advantages which are today at the disposition of Hamburg's oil industry and to steadily improve upon them. The deepening of the Lower Elbe, between the North Sea and Hamburg, and the harbor approaches, both now in an advanced state of completion, to 12 meters (39'4") at mean low water (or 14.3 meters—47' at mean high water) will permit the berthing of supertankers drawing 12 m (39'4") with a full load at the oil jetties of the refineries at Hamburg within the next few years. At present tankers of 36,000 dwt, drawing more than 11 m (36') are discharging in the port. A chain of shore based radar stations, under construction between the estuary of the Elbe and the oil docks, will be commissioned within about two years and will allow navigation of the river and the port channels in times of fog or low visibility and further ensure the safety of shipping in the port district and the quick turnaround of ships.

A considerable investment has been made in the improvement and development of oil discharging facilities and more is projected in order to increase the efficiency and the safety of oil handling. The existing petroleum harbor at Waltershof is being deepened and widened. A new large oil dock (Kattwykhafen) with a depth of 12 m (39'4") at mean low water and a docking capacity of 4 supertankers as well as a dock for smaller tankers (Schluisgrovehafen) with a depth of water of 11 m (36') at mean low water have been completed. Two more docks for supertankers are projected. For inland water tankers a special basin has been provided.

It may be stated with confidence that the Port of Hamburg is endeavoring to satisfy the petroleum industry as one of its principal customers (30% of the total cargo turnover by the port) by still further enhancing all the advantages offered by a great seaport situated well inland and a large consuming area. The development of this concentration of commerce and industry within the European Economic Community offers a favorable prospect for a further growth in the demand for oil, especially as soon as the advantages derived from Hamburg's geographical position have been further augmented by the completion of the Hamburg-Hanover-Frankfort-Basle Autobahn; by the electrification of German Railways line from Hamburg-Frankfort to Wurzburg; and the further improvement of canal connections for the use of the 1,000 dwt river barge. These measures are partly in hand and their progressive implementation is expected during the coming years. They open up favorable prospects for supplying large quantities of petroleum products to the continually developing industrial concentration in the Hanover, Brunswick and Salzgitter regions and, after the removal of present political obstacles, to Berlin, all Eastern Germany, Czechoslovakia and part of Poland as well. Though at the moment it is difficult to foresee a solution to the policial position, some day the advantages of Hamburg's natural geographical position will again become effective and the great chances of future development should not be lightly put aside when considering investment by the oil industry.

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The planning of oil pipelines

by Friedrich Zimmermann, Chief Engineer, Bohling Brothers

At a time when such terms as "rationalization", "automation" and similar words have become key-words of the world press and all industrialists, without exception, endeavor to produce their goods at minimum cost, it must seem peculiar that it can be seen again and again how little attention is being paid to the demands of maximum economy in the planning and the execution of industrial pipelines in general and oil pipelines in particular. In most cases this may be traced to the fact that little or nothing is known about the amounts which can be saved, although with careful planning a reduction of installation costs as well as a reduction of annual expenses may be achieved.

The following discourse was designed to give an overall picture of how planning and relevant calculations are to be carried out if all factors capable of affecting economy are to be considered. Over and above all this these factors will be individually considered and their influence in this or that direction illustrated. Based on the example, taken from a planned and executed installation, planning and calculation operations are easily explained.

The Firm Nynas-Petroleum AB, Nynashamn Sweden gave us the task of planning an oil pipeline for the conveyance of heavy crude oil, based on an hourly delivery of 80,000 US gallons.

Tankers discharge crude oil at a temperature of 140° F. Viscosity then amounts to 9,850 R" Redwood-Standard. The length of the pipeline was 11,480 ft and a difference of elevation of 115 ft had to be negotiated between the pier and the crude oil storage tank. The path of the oil pipe led partly over rocky areas and partly over swampy subsoil, so that installation on concrete supports or on piling poles was the most favorable. The terrain, partially unfavorable for inspection on foot, was also the reason for the incorporation of U-bend expansion equalizers, which do not require maintenance, as compensators where the pipe joints could not take up expansion due to the chosen path. Annual operational hours for oil delivery, power costs and heating costs were given. A set 15% was calculated for interest and amortization of the invested capital—referred to as "Capital Services" hereafter. Economy of the total installation was to be proved. Planning calculations went out from the fact that, according to experience, a flow of 130 to 180 feet per min. of the oil to be delivered, will produce rather favorable conditions with regard to economy. It must, however, be pointed out immediately that a larger pipe diameter will result in lower frictional loss and lower pump pressure required for the delivery of the aforementioned amount of oil, which is equivalent to lower annual expense for power required to drive the pump motors, but that a larger pipe diameter also means an increase of initial capital. This clearly shows that the most economical pipe diameter cannot be established automatically but that it has to be found. For his purpose calculations for pressure losses for three different inside pipe diameters were made as follows: $13^3/_4$" required a delivery pressure of 288 psi, $14^3/_4$" required 234 psi and $15^3/_4$" required 182 psi. Installation costs were calculated for each one of these three pipelines with the required shut-off parts, expansion equalizers and pumps with driving motors.

It has already been mentioned that heavy oil is discharged at 140° F by the tankers. This temperature must be maintained throughout the entire length of the pipeline, since a drop in temperature would influence the visosity of the oil so unfavorably that it would result in larger pipeline diameters and, consequently, higher installation costs. If one compares the following data, the influence of a drop in temperature is clearly evident. Heavy oil to be delivered has the following viscosity at temperatures given: Oil temperature 176° F, Viscosity 2,150 R", 158° F—4,040 R", 140° F—9,850 R", 131° F—13,880 R" and 122° F Viscosity 20,200 R". The pipeline must, therefore, be insulated to safely prevent a dropping off of oil temperature. On the other hand, the question arises as to whether it would not be advisable to raise the temperature in order to take advantage of the more favorable viscosity characteristics when making calculations. This point will be mentioned later.

It is customary in the oil industry to install supplementary heating in the form of a steam heated pipe of suitable dimension laid beside the oil pipe and insulated with it. In the existing case this method could not be used since the distance of 11,480 ft was too long. Subdividing the pipe into practical length heating surfaces would have to be undertaken, thus requiring the installation of a steam line and a condensation collecting line parallel to the heating surfaces. For the return of condensation, traps and condensation return pumps would be necessary, unless one decided right from the start to forfeit the return of condensate.

In this connection a suggestion by the customer to electrically heat the oil pipeline was carefully examined. The result showed, however, that electric heating would result in higher installation and heating costs.

The most economical solution with regard to installation costs and the required annual heating costs was found to be the use of hot water supplementary heating. Necessary hot water is produced by a hot water boiler in the boiler room of the refinery and is pumped through the heating pipes of the supplementary heating system by a hot water circulating pump. The supplementary heating represents a completely self contained pipeline which, starting in the hot water boiler, runs parallel to the oil conveyor line to the oil pier as forward line and returns to hot water boiler in the same manner. Forward and return lines are insulated with the oil line and are separated by an air gap from it. Maximum forward temperature of the hot water during severe cold amounts to 312° F and the return temperature to 194° F; the forward temperature can, however, be adjusted to the existing outside temperature.

When the total installation was handed over to the customer in the winter of 1956, a temperature of 10.4° F at Goteborg, the location of installation, was experienced. The supplementary heating had a forward temperature of 266° F and the thermometer for the return showed 197.6° F. The oil was discharged by the tanker at 140° F and reached the storage tank after a journey of 11,480 ft at a temperature of 141° F. The correctness of these measurements was checked by the exchange of thermometers at the beginning and at the end of the oil pipeline. Calculated temperature and the guarantee given for it was thus confirmed and fulfilled without having had to make use of the possibility of raising the temperature of the forward hot water.

After installation costs for all three pipe dimensions including insulation, pumps, and supplementary heating have been ascertained. Installation cost $13^3/_4$" was calculated at $177,500, $14^3/_4$" pipe $201,000 and $15^3/_4$" pipe $236,000.

Annual costs are as follows:

Pipe Diameter	$13^3/_4$"	$14^3/_4$"	$15^3/_4$"
Capital Services	$ 26,625	30,150	35,400
Radiation losses	1,375	1,430	1,490
Power cost	5,920	4,170	3,470
Total	33,920	35,750	40,360

Original investment in pipe is $23,500 higher for $14^3/_4$" and $58,500 higher for $15^3/_4$" pipe than for $13^3/_4$". Costs of earth work, concrete supports and servicing are the same in each case.

The only question remaining open is as to whether the heating of the oil to a temperature of 158°F or 176°F would serve any useful purpose in achieving a more economical capital outlay due to more favorable viscosity at these temperatures. This question can only be answered if the following calculations have been made:

A comparison with installation and annual costs for the pipeline with an inside pipe diameter of $13^3/_4$" at an oil temperature of 140°F shows that the installation costs at an oil temperature of 176°F would be $6,200 higher and the annual costs even show an amount which is $10,080 higher.

Installation cost of 10" pipe was calculated at $174,000; 11" at $183,700 and 12" at $192,300. Annual costs of 10" pipe total $44,840, 11" at $44,000 and 12" at $44,435.

For these reasons a heating to a higher temperature of 140°F was not carried out. In conclusion it may be said that the installation was erected according to this planning and that it has fulfilled all requirements with regard to operation, efficiency and economy since completion in winter 1956.

HOWALDTSWERKE HAMBURG A.-G.

built
Turbine Tanker "Esso Stuttgart"
47,000 DWT

Length overall 740'0"
Length b. PP. 705'-0"
Breadth moulded 102'-0"
Draught 37'-0"

Propelled by a Howaldtswerke Hamburg A.-G.
geared turbine 19,500 S.H.P.

"Oil flows, swims and rolls"

by Gerhard Geyer,

Chairman of the Board, ESSO AG, Hamburg

On November 29, 1958 the "Esso Frankfurt" moored as first tanker at the jetty of the northwestern oil pipeline in Wilhelmshaven. The first crude oil reached the Esso Cologne refinery on January 7, 1959.

The photo shows the river tankers "Esso Bingen" and "Esso Karlsruhe" in the harbor of the Esso Cologne refinery. These two tankers and their sister ship, the "Esso Koblenz," have a carrying capacity of 1700 tons and can only be used on the Rhine and the Main up to Frankfurt due to their draft.

THE production increase of the petroleum industry in West Germany during the last eight years has left almost all other branches of industry far behind. While the production index of all industry at the end of 1958 was 234 (1950 is 100), the index of mineral oil operations at the same date was 385. Similarly rapid increases have been shown only by transportation and the electro-technical industries. It is worthy of note that this index relates only to the West German refineries; imports of finished products, which since 1954 have also greatly risen, are not included.

The reason for this very rapid rise lies in the steadily increasing consumption of oil. Since 1950, in West Germany it has increased more than fourfold: from 4.4 million tons in 1950, it has risen in 1958 to 20.1 million tons.

This expansion is due mainly to three facts: growing motorization, the increasing preference that is given to heating oil as a source of power, and the inclusion of petroleum in chemical processing.

The number of powered vehicles has about tripled in West Germany since 1950; in the same period the consumption of energy has also tripled. Measured by weight, fuel oil has become the most important mineral oil product. In 1958 fuel oil constituted about 45% of West German oil requirements. For this reason, West Germany has attained a development that has taken other countries a longer time to reach. This change in the situation as regards oil requirements has led to the building of new refineries of special design. The new Esso Refinery in Cologne, for example, was specially designed for a large output of heating oil.

The chemical industry in Germany was formerly based, in the main, on coal. For some years now, hydrocarbons that are the prime materials for the manufacture of many products, have been produced from crude oil more economically than from coal. This established an increasingly important connection between the chemical and the petroleum industries. Hence, great chemical works have been built in the vicinity of new refineries.

The three factors, motorization, power consumption, and petrochemistry, are expected to create in West Germany during the coming years a further large growth of oil consumption. Even today, the imports of petroleum cover three fourths of domestic requirements, and this proportion will increase in the future. In this respect, West Germany is not a special case, because with few exceptions, all countries of the Free World must import petroleum. This oil will come from the centers of production in North and South America, and from the Near and Far East, where 90% of all petroleum that is accessible to the Free World is obtained.

In order to transport approximately 700 million tons a year in the most convenient manner, the oil industry has developed its own system of transportation, which in flexibility and economy must be regarded as a model.

Today the West German tanker fleet, including oil-ore tankers, has a tonnage of about 650,000 dwt. In recent years this fleet has grown remarkably, and yet it is only a little more than one percent of the world's tanker fleet. By 1965 the German tanker tonnage is expected to reach about 1.3 million tons dwt, and will then be in a position to transport 50% of the imported oil needs of the Federal Republic.

In this development the Esso Tankschiff Reederei G.m.b.H. has participated substantially. Esso's first building program in 1954 comprised four ocean tankers, each with 26,650 tons dwt; these were the "Esso Hamburg", "Esso Dusseldorf", "Esso Frankfort", and "Esso Munchen." The second building program now under way contemplates three super tankers each with 36,000 dwt and seven with 47,000 dwt. The first two of these ships, the turbine tanker "Esso Berlin" and "Esso Stuttgart" are already in service. At the conclusion of this building program the Esso Tankschiff Reederei will have, in 1961, more than 550,000 dwt and will be the largest ship builder in Germany.

When to this is added the fact that German shipyards are also building Esso Company tankers for foreign service, it may be seen that, since 1954, for the building of a total of 28 tankers, the Esso organization has poured into the German economy more than 800 million German marks.

Besides ocean tankers, the Esso Tankschiff Reederei has let contracts for building 16 tankers for local service, three with 1,700 tons each and thirteen with 1,000 tons each, of which 10 ships have been delivered in the past two years. All this new construction enlarges the available shipping capacity and contributes to stabilization of freight rates.

A second important link in the oil transportation system is the oil pipeline. For the west European economy there was at first only one large crude oil pipeline available—the Northwest pipeline. This project was initiated by Esso A.G. with participation of five other German oil companies, which hold about 47% in the new pipeline company—the Nord-West Oelleitung G.m.b.H. This line extends over a length of about 390 kilometers, from Wilhelmshaven to Cologne. After the first two stages in building this line were completed, it was possible to transport about 20 million tons of crude from the coast to the interior; this corresponds to loading 700 tankers, each with 37,000 tons.

Tank cars with a capacity between 10 and 15 tons are used for the transportation of petroleum products. Special products such as high grade lubricants or bitumen are shipped in barrels or drums in freight cars or on trucks.

Construction of the Wilhelmshaven-Cologne pipeline. The length of this pipeline including its branches is about 390 km (about 242 miles). The pipeline has a diameter of 71 cm (about 28 inches) and required an investment of about DM 231 million (about $55 million). Aside from the Esso Cologne refinery this pipeline supplies five more petroleum refineries in the Rhine-Ruhr district.

The building of the Northwest oil pipeline made possible the building of new refineries in the Rhine-Ruhr region. The necessary large quantity of crude oil previously could not be carried by waterways owing to the press of traffic on the Rhine and uncertain conditions of water level and variable weather. There was thus no absolute guarantee of a continuous water-borne supply of raw materials for plants in the area.

Transport by rail was excluded because the Federal railways would be forced to make an immense investment in tank cars and other facilities to handle the enormous volume of oil. Since the loaded tank cars would move in only one direction, the pipeline was determined to be the most economical means of transport.

In spite of their limitations the local tanker, railway car tanks, and the tank trucks constitute an important part of the oil transportation system. Super tankers and pipelines can indeed handle enormous quantities of oil over long distances, but they are certainly not economical when it comes to handling a multitude of containers which can hold only small quantities.

Most of West German refinery production is transported by water. In the case of Esso A.G., 70% of its output is distributed in districts that can be supplied by way of the Rhine and its connecting waterways. Two thirds of the 26 large Esso depots in West Germany can be reached by interior shipping. In addition to these the Federal railway is a valuable means of transportation. The largest part of the bitumen production, all lubricating oil, and almost all refinery products, are shipped in tank cars especially in winter when ice, fog and low water bring interior waterway shipping to a standstill. The tank car is the backbone of interior transportation. Tank cars serve in general for direct delivery to large consumers, or for sending smaller amounts to the depots. In neighborhood delivery from the individual depots the streets and the roads are always available.

In the past year alone the Esso A.G. has spent more than 80 million German marks for transport by interior waterways, rail and street. In coming years this amount will greatly increase. In view of the growing consumption of oil, the West German petroleum industry will have to solve new and larger problems.

Tanker construction

by Kieler Howaldtswerke A.G., Kiel

by Adolf Westphal

President of Kieler Howaldtswerke A.G.

In attempting to give a survey of the development of tanker construction in our yard, such study must comprise a period of exactly 50 years which is reason enough for a review of the past and for a look into future developments.

The transportation of petroleum began in the second half of the past century in vessels called petroleum clippers. These were fast sailing ships carrying kerosine in barrels, a thoroughly traditional method of shipment which, however, proved expedient only as long as quantities to be transported were rather modest as was the case in the early stages of development of the industry. With the rapid rise of sales of kerosine the idea of shipping bulk cargoes arose, and the German ship owner, W. A. Riedemann, was the first in the world to undertake the venture of building tanks that fitted tightly into the hull of a ship. He installed them in a sailing vessel, the "ANDROMEDA" in 1885. This utilization of space constituted a considerable improvement vis-a-vis shipment in barrels; but the decisive step towards the development of genuine tankers was taken with the order for two steam tankers, the "GLUCKAUF" and the "VORWARTS," placed by W. A. Riedemann in England in 1886.

Perhaps there is no general awareness of the fact that the development of freight and passenger ships as well as of warships has been a process of thousands of years, while tankers, the offspring of the modern petroleum industry, look back to only a relatively short history of 80 years.

After Kieler Howaldtswerke which had been founded in 1838 had already delivered a number of new ships, and amongst them a number of special ships for various types of use, the construction register of the yard shows the first tankers under the construction numbers 561, 564 in 1911-12, and nos. 580-582 in 1913. It was with a flourish of drums that Kieler Howaldtswerke entered the arena of contest with other building yards; and two interesting facts deserve not to be forgotten:

A start had been already made with a series of five sister vessels of 7,500 dwt which had been ordered by Deutsch-Amerikanische Petroleum Gesellschaft, a subsidiary of Standard Oil Co. of New Jersey although Kieler Howaldtswerke at that time had not had any special experience in the field of tanker construction.

One of the two ships built during the following year, 1913, was the steam tanker "JUPITER" of 17,610 dwt. "JUPITER" for a long time to come held the rank of the largest tanker of the world, and, almost 50 years ago had a size comparable with many of today's tankers.

The photographs of "KIOWA" and "JUPITER" show that even in 1911-1913 the basic appearance of todays modern tankers with the engine arranged aft, and the bridge midships had been developed. Propulsion was by oil fired reciprocating steam engines of about 1,500 hp in the "Indian" class, i.e. the "SIOUX," "MOHAWK," "TECUMSEH," "KIOWA," and "MOHICAN," and for "JUPITER" propulsion power had already reached 3,400 hp. Before the outbreak of the first world war another tanker of the size of the "Indian" class, the "PECHELBRONN", of 7,602 dwt was delivered to Deutsche Erdol-Aktiengesellschaft.

After this fine start of business with one of the leading oil companies, and what with the tanker "JUPITER" ranking for a long period as the largest of the world, the first world war interrupted the development of this peaceful cooperation. During the first world war the yard constructed eight smaller supply tankers for the Imperial German Navy.

Contrary to the last war Kieler Howaldtswerke suffered no damage at all during 1914-18, so that construction work in the postwar years was only handicapped by a shortage of material and political unrest and strikes. By 1920 the old business relationship with Standard of New Jersey and its subsidiary companies had been resumed by the delivery of the "GEDANIA" and "VISTULA" of 14,100 dwt each, followed up to 1926 by the "PHOEBUS," "PROMETHEUS," "PENELOPE," "LEDA," "CALLIOPE," "URANIA," and "THALIA." During the first 15 years after the inception of tanker construction in 1911 Kieler Howaldtswerke delivered 200,000 tons of tanker tonnage, of which not less than 185,000 tons had been for Standard of New Jersey.

Apart from this technical achievement it should not be forgotten however, that already in the twenties extraordinary price increases owing to strikes and for political reasons occurred which made the yard suffer heavy losses, as construction contracts were based on fixed prices. The financial problems of price increases and of fixed prices, for these reasons, date back 30 years.

In 1928 we delivered the "ELENA," a tanker of 3,000 dwt to the Anglo-Saxon Petroleum Co. This ship had to be completed by section chiefs, foremen and supervisors in order to avoid a delay in the delivery owing to strikes. This won the confidence of the Shell group; and during the thirties four more tankers, viz the "CIRCLE SHELL," "GADILA" etc. of a total of 43,000 dwt were delivered to Shell.

For this latter construction project Howaldtswerke acquired for the first time an engine construction license from the Dutch company, Werkspoor N.V. because the ordering owners in their building specification had prescribed this type of engine, but Werkspoor, owing to crammed order books, could not supply the respective engines; on the other hand Kieler Howaldtswerke, naturally, wanted to prove its fine capacity for engine construction. A license, was, therefore, obtained from M.A.N., for the engine of about 3,500 hp for M. T. "GADILA" delivered to Shell. This engine constructed under the M.A.N. license and equipped with a Werkspoor supercharge was a great success.

When Kieler Howaldtswerke had completed the first quarter million of tanker tonnage, the total tonnage of tankers in the world was eight million gross register tons. The Kiel shipbuilding industry of all German yards has had the most important and largest share in

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Fig. 3: Modern supertanker.

tanker construction. The clientele expanded from Standard of New Jersey, Shell, Deutsche Erdol A.G. to include Socony Vacuum Oil Co. and Gulf Oil Corp.; however, in all the years between the two world wars sizes of tankers remained at approximately 15,000 dwt and nobody dared even in the boldest dreams to think of the fantastic increases in tanker sizes which we were to experience after the second world war.

The second world war brought the most complete destruction of Kieler Howaldtswerke by bombing raids, and planned blowing up of facilities afterwards. We were faced only with ruins and rubble; there was neither food, nor coal, nor material. We did not even have permission to work in the old business, or to participate in the new construction business, towards the meeting of the sudden wave of pent up demand almost drowning the industry in other countries with orders. The first few postwar years were spent in clearing and repairing the devastated yard facilities. One day a ship owner approached us again and entrusted us with the job of reconstructing and converting a sunk and salvaged tanker, the "KOLLGRIMM." By this and other conversion jobs, of which the conversion of a T-2 tanker into a whale factory ship, i.e. the "OLYMPIC CHALLENGER," was, perhaps, the most difficult and most successful job, whereby we could again establish the good prewar reputation which we had enjoyed among tanker shipping companies in the world. Thus, we were able again to create the basis for developments of the last few years. Moreover, several C 1 A ships were converted into LP-Gas tankers, which put the pipe system construction department of the yard under a great strain. The delivery of the first new tanker after the world war occurred in 1952, when the motor tanker "JALANTA" was handed over to Pankos Operating Co., Panama (Anders Jahre), and "NORTHERN PRINCE" to A. Pappadakis, both ships were of 18,400 dwt and thus of the then standard type.

The complete destruction of the yard facilities during the war in one way was a great advantage by ridding us of the old-fashioned overhead steel superstructures and stagings for the building slipways, i.e., for cranage etc. The narrow parallel slipways available then would not have enabled us to carry out reconstruction according to most modern principles, which now has placed us in the position to compete with any yard in the world under aspects of construction time and of price. All new construction berths and slipways have, over their entire lengths, the parallel facility of the necessary welding skids right alongside so that the cranes can move entire sections over the total length of the ship under construction. By the introduction of modern welding techniques and every other modern method of mechanization and automation, construction time has been substantially reduced and the total capacity increased to approximately 400,000 dwt per year. Concurrently with the improvement of the ship construction facilities, the workshops for engine construction, too, were expanded and modernized. Kieler Howaldtswerke is able

Fig. 1: Kiowa, 1911 model tanker with silhouette similar to current vessels.

Fig. 2: The 17610 dwt Jupiter, world's largest tanker in 1913.

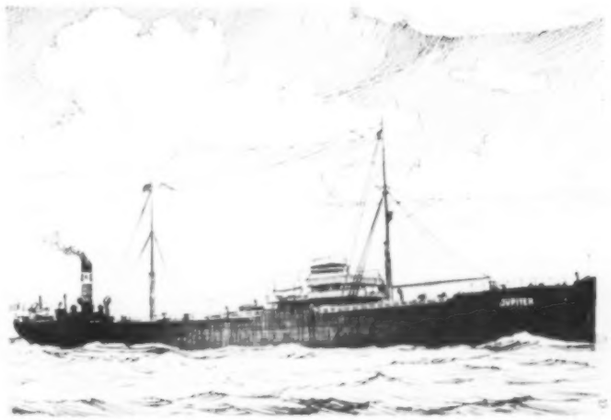

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Fig. 1—Ready for laying the next keel.

to build diesel engines under M.A.N. license of up to about 20,000 hp and the engines built by the yard enjoy special confidence and liking by owners. Also in the field of boiler construction interesting progress has been made. Marine boilers of our own manufacture and type and under license from Foster-Wheeler have been built. The combination of Howaldt business and Howaldt boilers results in fuel consumption of only 225 g per SHP per hour, which means top economy. All tanker buildings are almost entirely equipped with engines, turbines, and boilers of our own make.

1953 brought deliveries for further ships of 18,400 dwt type, and the beginning of a series of ten 21,500 dwt turbine tankers for A. S. Onassis, which were delivered by 1954. In 1954, moreover, there were the first two 32,500 dwt turbine tankers for S. Niarchos, and a total delivery of 218,000 dwt tanker tonnage that year. In the years following, standard types of 21,500 dwt, 25,900 dwt and 32,500 dwt were built, and moreover, the construction of ore oil bulk carriers undertaken. In 1955 the jubilee construction number "1,000" was launched, this ship being the 32,500 dwt turbine tanker "HOEGH GRACE" for Leif Hoegh of Oslo. Last year the first 40,000 dwt turbine tanker, the "JAKINDA," was delivered to our good friend Anders Jahre. This vessel was at that time the largest vessel under Norwegian flag.

The ever increasing sizes in international tanker shipping which after the war had brought about a doubling of standard sizes of 18,000 dwt to 30-40,000 dwt have caused the yard to erect building sites and berths for ships of practically any size. Apart from the slipway for ships of up to 70,000 dwt two large drydocks were completed, which offer facilities for new construction and repair of tankers over 100,000 dwt. At the present time Kieler Howaldtswerke has the following berths facilities for shipbuilding purposes:

1 Drydock for ships exceeding 100,000 dwt.
1 Drydock for ships of up to 65,000 dwt.
1 Slipway for slips of up to 65,000 dwt.
1 Slipway for ships of up to 40,000 dwt.
3 Slipways for ships of up to 26,000 dwt.

All slipways are equipped with most modern mobile cranes of 40 tons lifting capacity, and the layout is arranged for interchange between all necessary ship and engine workshops, as well as the many other workshops needed for the final equipping and completion of ships. The labor force has increased from 3,500 at the beginning of the construction of the first tanker in 1911, to a figure of no less than 13,500 today. The tanker tonnage delivered to date amounts to about 80 ships of a total of 1,250,000 dwt of which the years 1952-58 alone account for approximately 900,000 tons, or $^{3}/_{4}$ of the total. One could, perhaps say that for Kieler Howaldtswerke the share of tankers in the tonnage of new ships delivered has risen substantially faster than the share of tankers in the tonnage of the world merchant fleet during the same period of time.

At the moment of writing the largest merchant vessel built in Europe at any time, the turbine tanker "OLYMPIC CHALLENGER" of 65,000 tons dwt is being delivered. The present order book for new tankers exceeds by 50% the total deliveries since the very beginning of our tanker construction, for it comprises almost 1,800,000 dwt. The following is the order book for tankers on order that have not yet been delivered:

2 ore oil bulk carriers of 6,000 dwt each;
2 ships of 18,000 dwt each;
8 ships of 26,000 dwt each;
3 ships of 32,000 dwt each;
9 ships of 40,000 dwt each;
3 ships of 27,000 dwt each; and
10 ships of 65,000 dwt each.

Moreover, preliminary contracts have been concluded for two 87,500-ton tankers with the option of the owners, one of our major customers, to enlarge the size of these ships to over 100,000 dwt.

At the beginning of the period under review, i.e., in 1913, we had supplied the then largest tanker of the world, and at the end of the period of this report, the greatest tanker ever built in Europe is being delivered, with contracts having been made which will perhaps, make us one day again supply the largest tanker of the world. Kieler Howaldtswerke is prepared to meet any and all technical requirements of tanker shipping companies, based on the experience of 50 years of tanker construction, and thanks to a staff of specialized designers and a labor force the major part of which has been connected with our yard for several generations past.

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Is Wilhelmshaven to be Europort No. 2?

by Town Counsellor Arthur Grunewald, Wilhelmshaven

THE new Wilhelmshaven oil tanker terminal went into service at the end of last year, and more than 1 million tons of crude oil have been discharged in less than three months. It is too early to predict at this time the volume of crude oil that will be discharged in the first year and in the following years to come but it is safe to say that in a few years the pipeline running from Wilhelmshaven through the Rhine/Ruhr industrial area to Cologne will be carrying crude at its full capacity of about 22,000,000 to 23,000,000 tons/year. The new oil terminal has made Wilhelmshaven a newcomer among German commercial ports; it has initiated a development which is essentially different from the previous functions of the port because for more than 100 years Wilhelmshaven was known as a naval base only.

Oil, indeed, is the life blood of industry and pipelines are the arteries to supply industry with this life blood. As an economic artery of utmost significance, the pipeline connects Wilhelmshaven and the Rhine-Ruhr industrial area. It is a matter of common interest to all European nations and in particular of those who participate in the Common Market that this connection should be developed and expanded in the future.

The Rhine-Ruhr industrial area is the heart of the Federal Republic's economy and the largest industrial complex in Europe. This potential industrial area which maintains world-wide economic relations requires efficient seaports to import raw materials and to export finished products. These functions are still well fulfilled by the chain of ports stretching from Antwerp in the west to Hamburg in the east. Though these ports have been able for several decades to steadily expand their turnover volume, much concern is spreading among the German group of ports that their volume may drop considerably in the future. This danger is not without a tragic note because it will not actually make itself felt until the Common European Market which is expected to produce a general economic upswing begins to show its effects. Owing to their location on the periphery of the Middle-European industrial center in the Rhine/Ruhr area, the German ports are to be displaced by ports on the far side of the booming industrial centers. The Rhine-Maas-Schelde ports, the so-called Benelux ports, and Rotterdam in particular, continue heading into the foreground. This process is attributable to Rotterdam's unique economic-geographical position which offers three outstanding advantages:

1. The distance from Rotterdam to the Western Ruhr area (not to the Eastern Ruhr area) is shorter than from any German seaport.

2. Rotterdam and the Ruhr area are connected through the Rhine, the best European inland waterway.

3. The ocean route from overseas countries to any German port is longer than to Rotterdam, the difference being the distance from Rotterdam to any one of the German seaports.

Expansion schemes have been established for all Benelux ports and efforts are being made to deepen and to enlarge their fairways. Some of them have had this job under way for several years but Rotterdam's efforts have been made on a scale unparalleled by any other port and it is for this reason that Rotterdam is right in calling itself Europort. This development implies the question of future prospects for the port of Wilhelmshaven and of the steps to be taken to benefit from such prospects. Plans for the future would be of little value if they were made from a purely local, and even German, point of view because we are on the way to the Common European Market and are to face the consequences of this development.

The turnover volume of the Rotterdam port went up from 42 million tons in 1938 to 75 million tons in 1958 while Hamburg, Germany's largest port, recorded only 27 million tons this year. For 1970 the turnover is estimated by the Rotterdam port administration at 124 million tons. This giant figure has been set forth on the Netherlands' belief that the Common European Market will be accompanied by an economic upswing that will exceed all records of previous periods of prosperity.

The development of Rotterdam's turnover volume is a story of rapid growth resulting from three main factors.

1. The ever-increasing expansion of economic power of the industrial areas on the right and left side of the Rhine within reach of Rotterdam.

2. Development of the Rhine river itself.

3. The declaration making the Rhine an international waterway.

At the junction of the Rhine and Ruhr rivers we find Duisburg-Ruhrort which in recent decades and for similar reasons as Rotterdam has come to be the world's largest inner harbor. Owing to their favorable situation, both Rotterdam and Duisburg will continue to grow fast but their growth will reach natural limits because no port can attain an unlimited expansion of its handling potential and also the Rhine river, broad though it is, cannot offer an unlimited capacity.

In 1957 more than 20,000 seagoing ships and over 200,000 river boats landed at Rotterdam for discharging their goods or loading cargo and the latter returned upstream either empty or carrying cargo. If the prediction made for the Rotterdam port of 1970 proves correct, 35,000 sea-going ships will call at the port by that year and more than 325,000 river boats will sail up or down the Rhine and . . . obstruct the river. It is of little importance whether such a situation will materialize in 1970 or whether it will present itself some years earlier or later. But there can be no doubt that we shall have to face this situation some day and it is equally true that this development and any consequences to be derived therefrom for the German ports deserve the closest attention from all European economic quarters. This applies in particular to German trade and industry and the German administration. The present impression is that leading German shipping interests show an increasing tendency to engage themselves in Rotterdam and that certain industrial concerns in the Rhine/Ruhr area are planning to shift capacity expansion into the zone of Rotterdam. Such a development would terminate in the formation of an industrial center in the southwestern coastal area of the Netherlands similar to that of the Rhine/Ruhr area; it would lead to a concentration of economic activity which is likely to create for the German administration very expensive and insoluble problems in the fields of health service, traffic, air-raid protection and military safety. It is easy to realize that such a development would not be in the interest of either the Netherlands or Germany nor would it serve Europe as a whole, all the more since it would lead to the creation of a port monopoly for Rotterdam.

As far as the transportation of iron ore from the seaports to the steel mills is concerned, the German metallurgical industry has from its earliest days been anxious to maintain a sound competition between railway and the inland shipping companies. It has thus been able to prevent the creation of a monopolistic position by a single transport interest and to negotiate low tariffs. Similar considerations lead to the refusal of a port monopoly for Rotterdam because such a monopoly will not serve the interests of the whole European trade and industry as far as it necessarily depends on imports and exports from the Northsea ports.

Here the eminent need becomes obvious for old Europe to get a young Parliament faced with the challenge to set up the principles which are likely to strengthen the economic potential of Europe and to avoid mal-investment of funds and which should provide the basis for a regional political economy that will achieve the bright target. The need for a further development of Wilhelmshaven to become Europort No. 2 appears more urgent in the light of the recent trend to build large vessels and of the aspects of the future transport of bulk articles from and to overseas in vessels of 60,000 to 100,000 tons considering that Rotterdam's present port development scheme is for vessels not exceeding 65,000 tons and that this harbor probably cannot be carried to still greater water depths. The European economic system and especially the German economy cannot disregard the price advantage of large vessels in the sound competition of several efficient ports.

These facts are supplemented by further considerations: the costs per hour of voyage or stay rise with the volume of the vessel. Loading and unloading of large vessels must be fast. This means that, for economic reasons, it becomes more and more necessary for larger vessels to call at outer ports, i.e. ports situated at the open sea in order to avoid time-consuming maneuvering through locks, narrow harbor basins and long access ways. It further implies that the fairways must be broad enough to permit troublefree maneuvering at any time; finally, it is important that navigation on the access routes to the outer ports should not encounter difficulties, delays or even obstructions owing to fog or ice formation.

Wilhelmshaven is an outer port and a lock port and has fewer days of fog and ice than any other North Sea port. Among the group of North Sea ports, Wilhelmshaven offers the best and broadest fairways which is now steadily maintained and deepened. Predictions by top German experts say that the fairway can be carried to a depth of 14 meters at springtime low-water which is equal to a water depth of 17 meters (45.11' and 55.9' respectively) at high tide. In the experts' opinion, such a development can be achieved at a reasonable expenditure and at current maintenance costs which will be the lowest among the group of coastal North Sea waterways. The outer port of Wilhelmshaven which is intended for bulk handling only, offers a fairway which permits the passage of the largest ships at relatively high speed up to the wharf.

In the light of these facts there is much to be said in favor of the development of Wilhelmshaven to become Europort No. 2 for handling bulk cargoes. This target must be accompanied by the construction of an inland waterway into the Rhine Ruhr area. It is obvious that such a waterway should be a genuine competitor to the Rhine, that means it must be able to carry ships carrying 2,000 tons of cargo. A matter requiring expert decision is whether this waterway should run from Wilhelmshaven through the coastal canal into the Dortmund-Ems Canal or through the Ems-Jade Canal into the Dortmund-Ems Canal. It is imperative, however, that the waterway be routed into the industrial area around Dortmund where it would be followed by the gradual but faster-than-expected development and growth of a central Ruhr area port which would be hardly less important than that of Duisburg-Ruhrort and from which further canals could branch off to serve other zones of the Ruhr area. In this way the Ruhr area would have the advantage of a second "Rhine estuary" at the North Sea coast and at the same time of a second central port for the area proper.

Inasmuch as such a development will also touch the interests of other German ports, it will be necessary to come to a mutual agreement on the interests and functions of these ports to define an economically sound division of activities which is likely to produce benefits for the whole group of German ports and to put them into a stronger position in their economic race with the Benelux ports. The interests of other German ports would equally have to be considered in the construction of a waterway from Wilhelmshaven into the Ruhr area and this construction should mark the beginning of the development of a well-designed and efficient canal system incorporating all German ports.

The need for such a development cannot be disregarded by anybody who recognizes in principle that the capacity of any port is limited just as that of any parking area. It is unreasonable to make available a single parking ground for 100,000 cars or more because access and outlet ways would be too long with consequent time-consuming driving. It is just the same with ports. But when the time comes for Rotterdam to see its handling capacity exhausted, the port administration will necessarily expect to reap more profits from the cargo handling job by expanding this attractive piece-goods business at the expense of bulk cargoes. For this reason, too, and in the interest of the Common European Market there appears to be a genuine need for an early development of Wilhelmshaven to become the second bulk cargo terminal.

All interests concerned should realize that in paving the way for new and large-scale economic developments it is imperative for the transport interests of any kind to devote their share to that development. Further, there must be no shadow of a doubt that the problems involved must be tackled very soon unless Germany is allowed to be outdone in this development. In view of the great interest shown by overseas countries and especially by the United States in the European economic system in the light of the emerging picture of the Common Market, the assumption may be justified that serious negotiations will be initiated in the very near future in international economic and shipping business quarters to discuss the future development of Wilhelmshaven to become Europort No. 2.

W I L H E L M S H A V E N

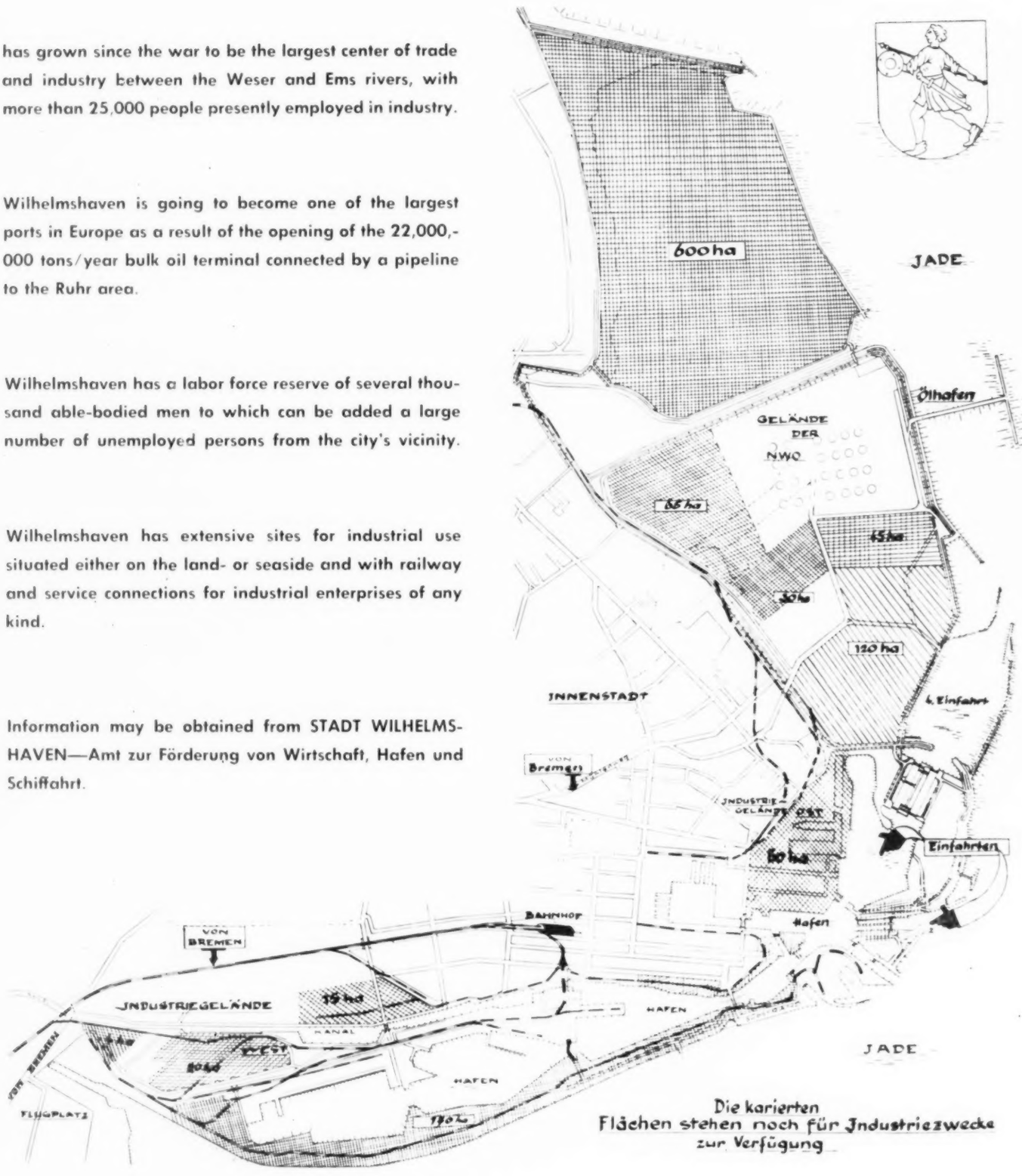
has grown since the war to be the largest center of trade and industry between the Weser and Ems rivers, with more than 25,000 people presently employed in industry.

Wilhelmshaven is going to become one of the largest ports in Europe as a result of the opening of the 22,000,-000 tons/year bulk oil terminal connected by a pipeline to the Ruhr area.

Wilhelmshaven has a labor force reserve of several thousand able-bodied men to which can be added a large number of unemployed persons from the city's vicinity.

Wilhelmshaven has extensive sites for industrial use situated either on the land- or seaside and with railway and service connections for industrial enterprises of any kind.

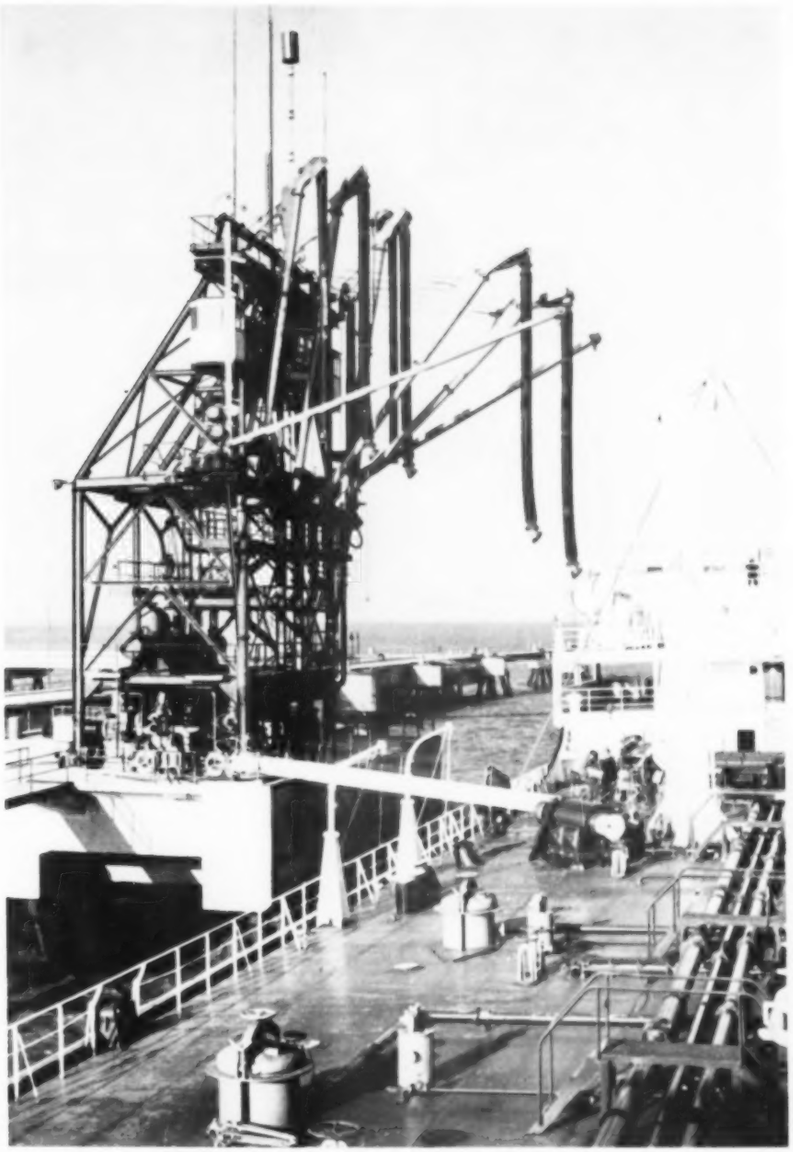
Information may be obtained from STADT WILHELMS-HAVEN—Amt zur Förderung von Wirtschaft, Hafen und Schiffahrt.



Die karierten Flächen stehen noch für Industriezwecke zur Verfügung

Crude Pipeline from the North Sea to the Rhine

by H. Dr. J. Burchard
Nord-West Oeleitung GmbH
Wilhelmshaven



In the early days of January 1959, refineries in the Rhine Ruhr area received the first oil stream that was piped from Wilhelmshaven. Construction of the pipeline had begun eight months before.

Late in November 1958—only one year after the beginning of construction work on the oil terminal—the first tankers coming from Venezuela and the Near East were unloaded in Wilhelmshaven.

These two dates mark the beginning of a new chapter in the history of Western Germany's crude oil supply. On the one hand, a new oil tanker terminal went into service whose significance for the future is beyond any doubt; on the other hand, pipelining crude to refineries was a break in European tradition.

New methods of transportation of crude to the refineries had become indispensable to safeguard a continuous supply. The processing of imported crude stocks has so far been centered in the area of the seaports. Consequently, 66% of the imported overseas crude passed through the ports on the Elbe and Weser rivers, the balance of 34% being handled by the Rhine terminals. However, a glance at development in recent years shows that the portion of crude transported on the Rhine has been steadily rising at the expense of the Elbe. This provides a conspicuous hint at the growing importance of the refineries situated in the consumption centers of the Rhine Ruhr area. It may be expected that by 1965 about two thirds of the Western German refinery capacity will be situated in this area.

Crude oil alone will account for an additional stream of products which is best illustrated by two figures: Approximately 7.4 million tons of crude oil were processed by the Rhine Ruhr refineries in 1957; estimates for 1965 run as high as 22 million tons. These figures should be visualized bearing in mind that in both cases part of the refineries' crude requirements comes from domestic fields.

The Rhine is an efficient waterway running through the Rhine Ruhr area. However, exploitation of the river's capacity has by now reached a point where the shifting of further traffic streams to the Rhine is likely to become a source of delicate problems. The situation is further aggravated in that river navigation depends on weather conditions including floods and low water level and especially drift ice which often obstructs normal activity over many weeks. The outstanding problem, however, is that, with rising demand, waterway transportation cannot provide an absolute safeguard to meet the refineries' most exacting requirement, namely a steady stream of crude flowing towards their facilities. It is for this reason that a decision was made in favor of a pipeline.

In selecting the starting point of the pipeline, consideration had to be given among other things to the trend in tanker building which has been moving for some time towards the construction of large vessels. Tankers of 47,000, 65,000 or even 100,000 dwt require harbors with fairways of sufficient depth.

Tanker Marathon mooring at the jetty at Wilhelmshaven

A careful study extending to all ports under consideration revealed that there were only few ports in Europe deserving closer attention. Wilhelmshaven was finally found to offer the best natural conditions.

There is no appreciable influx from inland waterways which might contribute to silting up the Jade Bay, which, thanks to tidal action, has a gravel bed two meters thick that is ideally suited to harbor requirements. The approach to the harbor is also relatively stable. The depth of the fairway is still sufficient to permit tankers up to 36,000 dwt to land during high-water though no dredging has been done since 1942.

Previous experience indicates that the fairway can be carried to a greater depth at comparatively low cost. This work is an absolute must to permit super-tankers to go alongside the tanker pier. No difficulties exist in the immediate vicinity of this newly-built pier as the natural water depth is 15 meters during low tide and about 19 meters during average high tide. So, tankers up to 100,000 dwt can moor on the outer side of the tanker pier while the inner side can be used by tankers up to 47,000 dwt.

In the meantime, an up to date bulk oil terminal has been created in Wilhelmshaven. For the present, three unloading assemblies have been installed on the pier with connections for discharging the crude from the tankers and for the supply of the vessels with bunker oil and fresh water. Each unloading assembly can handle 6,000 m^3/h so that the total facilities have an aggregate capacity of 18,000 m^3/h. Obviously, the actual volume of crude handled depends on the tankers' pump capacity.

A tank farm has been erected for intermediate storage of the crude in 14 floating roof tanks having a volume of 31,500 m^3 each. The diameter of the tanks is 55 meters, and the height 13 meters.

Wilhelmshaven also houses the only pumping station presently available for the whole pipeline. At a maximum pressure of 60 to 70 atm g. the station is capable of delivering about 9,000,000 tons year. A second pumping station is scheduled for erection midway between Wilhelmshaven and Cologne; another two stations will be added later if and when required. The ultimate capacity of the pipeline will then be around 20,000,000 tons per year.

The pipeline will ensure crude supply to seven refineries enumerated below in the order of branch lines:

Refinery of Gewerkschaft Erdöl-Raffinerie Emsland at Lingen-Holthausen.

Ruhr-Raffinerie of BP Benzin und Petroleum AG. at Dinslaken.

Plant Scholven of Scholven-Chemie AG. at Gelsenkirchen-Buer.

Refinery of Ruhrchemie AG. at Oberhausen.

Refinery of Purfina Mineralol-Raffinerie Aktiengesellschaft at Duisburg.

Refinery of Esso AG. at Cologne.

Plant Wesseling of Union Rheinische Braunkohlen Kraftstoff AG.

The main line extends over a length of 318 km. The overall length including branch lines is about 390 km. Pipe has a diameter at 28 inches and a wall thickness varying between 11.9 and 7.9 millimeters.

Laying of the pipeline involved many technical difficulties owing to varying soil conditions including the crossing of mining areas exposed to settling and the routing along water supply zones. Fifteen rivers and canals and numerous rivulets required the use of underwater crossings, the Rhine crossing is 400 meters long. Crossing was further required at 206 roads and 58 railway lines, the pipeline being laid in a protective sleeve at such places. Land had to be secured from 2,308 owners.

At the beginning of 1959, the new German bulk oil terminal at Wilhelmshaven and the pipeline created a new artery of transportation which has stepped into the limelight of public interest. A steadily increasing oil stream will now be flowing from the tanker pier in the Jade Bay to the Rhine Ruhr refineries.

Terminus at northwest pipeline Wilhelmshaven to Wesseline
Photo: courtesy NWO

Modern tank ship unloading installations in the Mediterranean

(Continued from page 200)

2. The Augusta (Sicily) Plant.

Contrary to Ravenna, the port of Augusta has a roadstead that is very well shielded from the open sea by a mole. It is within this roadstead that the artificial island is situated at a distance of approx. 0.7 mile off the shore. Due to better mooring facilities, the vessels are here always able to berth on dolphins alongside the unloading island. The tanker's hose connections, located about midships, can thus be reached more easily than at the Ravenna plant where most vessels have to be loaded over the stern on account of the choppy sea.

The island is practically twice as large as that of Ravenna, i.e. 98 x 49 ft. instead of 49 ft. in diameter, and it is equipped with two cranes which correspond largely to the one at the Ravenna installation, except that they are designed to handle four 10-inch hoses instead of four 8-inch hoses. The stocks of navigation signals, semaphores etc. are also basically similar to those at the Ravenna island, but there is only one platform. Due to the larger platform area, two cranes, and a suitable arrangement of dolphins, it is possible to handle two ships simultaneously. (Fig. 5.)

The number of pipes leading to the Augusta plant is considerably greater than at Ravenna, and they are not submerged but laid on a catwalk above sea level. Most of the pipelines run from the catwalk upwards under the platform where they are supported on brackets independent of the platform proper and led further upwards through an opening in the platform. This opening is so dimensioned that a vessel may push the island sideways 3 ft. shoreward and in both horizontal and vertical directions without making the platform touch the pipes.

This opening is covered with an oil-tight plate. Swivel bends are fitted to the pipe ends, enabling the hoses to follow the slewing motions of the crane caused by the rolling of the ship. The cranes are positioned out of platform center to make possible the operation of the control batteries.

Although the island can stand a ship's thrust, a number of dolphins was provided to protect the island against immediate contact with a vessel and safeguard trouble-free berthing.

Owing to the tremendous forces exerted on the dolphins, 32-inch pipes were selected to form a bundle of eight in each dolphin. Having lengths up to 138 ft., these pipes were rammed 49 ft. into the ground.

The northern and southern dolphins are designed for mooring rope pulls of 150 tons and 120 tons respectively. There was not enough room left under the platform to install a 24-inch crude oil line. This is, together with a water line, supported by brackets attached to the shoreward side of the platform. The connections required for this pipeline are arranged in front of the control batteries. This installation was ordered by the RASIOM refinery.

Technical description of the dolphin structure and slewing crane. (see sketch)

Since the Augusta plant has only one platform against the two at Ravenna, the slewing crane could not be fixed between two platforms, but called for a special holding structure. This was built underneath the platform and consists of eight pipes guiding the lower end of the pivot column. The platform surface is essentially free for the unobstructed movements of the flexible hoses between the dolphin and the swivel pipe bend and for work on the hoses, but it is possible to set up cabins there.

The dolphin structure described above merely receives vertical forces due to the platform and crane loads. The platform and tubular piles are further designed to take up horizontal impact up to 3 ft displacement in the direction of the ship's thrust.

The slewing cranes used here are principally similar to the one at the Ravenna plant. It is therefore referred to the specifications of this installation.

Both installations were built under the general management of Mannesmann AG., Duesseldorf, and with the supply from the company's affiliated plants, while the operating platforms and slewing cranes were provided by the firm Stahlbau Eggers and Friedrich Kehrhahn GmbH., Hamburg.

Right: Tanker unloading island off shore from Ravenna, Italy.

Left, above: Diagrams showing how tankers are anchored for unloading. Below: Method of connecting unloading hose between tanker and submerged pipelines.

The railroad tank car in the European traffic of mineral oil

by Kurt Toebs, Director of VTG
Vereinigte Tanklager und Transportmittel GmbH., Hamburg

Historical Development

The transition of transportation of imported petroleum products from barrels or other small containers to bulk transport in modern large tank cars has been an important step which is evident to all. The change has paralleled the great industrial development which began in the second half of the past century.

Motorization was introduced by the invention of the internal combustion engine in 1876 by Nikolaus Otto and its development was ensured by practical application as a driver for bicycles and tricycles by Daimler and Benz in 1885. The need for petroleum products has grown steadily since then and, as we know, is still climbing. Concurrent with this continuously rising demand for oil products caused by the technical revolution, the European petroleum industry developed to its present importance.

Transportation needs for oil products also have changed because of fast rising consumption. Shipment in barrels is no longer sufficient and furthermore is unsuitable. Larger transport units had to be found. In order to ship a large quantity as a unit, the idea developed of putting a large "barrel" on the chassis of a railroad car. Thus the railroad tank car was created as a means of modern transportation. In Germany it was first used for shipment of acids.

At first railroads had only a few tank cars in their rolling stock and because of the special construction of such cars and complex financial engagements, it was exceptional when they supplied special cars for forwarding liquids. At an early date railroads permitted private owners to run open or covered wagons on their rails because they did not have an adequate number of cars. Soon they extended this permission also to special cars, particularly tank cars. Thus the privately owned car being immatriculated with the rolling equipment of the railroads was created. With few exceptions all tank cars running in Western Europe are still privately owned.

Since 1838, in Germany private owners have been allowed by legal regulations to forward cargo in their own wagons. But it was not until the last 20 years of the 19th century that private car stocks attained practical importance.

In 1884, 320 tank cars were counted in the territory of the "Preussische Staatsbahnwagen-Verband," 50% of which were owned by the railroads. Only 12 cars were used for the conveyance of petroleum products. By 1900, there were 3850 privately owned tank cars running on all German railroads. 1030 of these cars were used for forwarding oil products.

The railroads as well as the owners of privately owned cars being immatriculated in the rolling equipment of the railroads were interested in regulating by contract the mutual rights and duties arising from the immatriculation of privately owned cars. From this the so-called "immatriculation conditions" arose, the first wording came into force in Germany in 1874. On September 13, 1872, the "Conditions générales réglant l'admission des wagons des particuliers sur les chemins de fer de l'Etat" were published in Belgium.

Although these dates concern almost exclusively the German situation, it may be assumed that the development in other European countries as a whole took place at about the same time and in a similar manner.

Contacts between private owners and railroads have been subject to many changes and for a long time were determined by the monopoly the railroad held as the only efficient carrier of the period. After world war II both railroad and private owners were forced by the increasing competition of other carriers to look for new ways of cooperation.

Private owners of tank cars are faithful customers of the railroads. They want to utilize their tank cars and thus their capital as long as possible. Railroads want to forward as much cargo as possible. The interests of both should create acceptable conditions under which privately owned tank cars may be used on railroad lines. The mutual effort of both sides is best expressed by the continuous cooperation between the "Union Internationale de Chemins de Fer (UIC)" and the "Union Internationale d'Associations de Propriétaires de wagons particuliers (UIP)." This, of course, has not yet led to a satisfactory solution of all problems, but finally will guarantee a coordination of mutual points of view in all important questions.

It is noteworthy that beginning January 1, 1953 railroads granted an allowance to private owners or to freight payers with respect to freight payers for every consignment forwarded in privately owned cars. This is done because of the fact that freight charges are the same as for shipments in railroad cars even though privately owned cars have been used. Railroad costs are lower because the railroads do not supply and maintain tank cars. French railroads (SNCF) have paid this "redevance" for many years, and in USA this has been known as mileage allowance since the beginning of the century. It should be mentioned that UIC in cooperation with UIP has concluded immatriculation conditions, the application of which is compulsory in international traffic for all railroad administrations which are members of UIC and these conditions are recommended for all inland traffic.

Conditions for transportation of privately owned cars on international lines are laid down in Annex VII (International Regulations concerning the haulage of private owners' wagons—RIP) to the International Convention concerning the carriage of goods by rail (CIM).

An enormous change has taken place from the historical beginnings previously described. Now very different oil products roll along the rails, mostly as bulk cargo, in tank cars and in tremendous volume. This may be seen from the fact that in Western Europe about 60,000 tank cars are being used for shipping petroleum products. According to approximative statements, in the United States

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about 120,000 railroad tank cars, mostly of large capacity, are employed in the same service.

Who owns railroad tank cars?

Since, as mentioned before, railroads did not supply tank cars for public traffic, importers and dealers in petroleum had to provide their own tank cars for the conveyance of the steadily rising quantities and to immatriculate them in rolling equipment of railroads. With increasing consumption of oil, the number of tank cars owned by the great oil companies rose to a large figure.

The consigners of mineral oil, mostly the well-known companies such as Esso, Shell and BP, become owners of tank cars on a large scale and adjusted the construction of their cars to their individual needs. Supply, maintenance, administration, and disposition of this large rolling stock demanded specialists charged with technical care and employment of the cars so that utilization could be as high as possible and costs held to a minimum.

Shippers were not always able to meet the demand for cargo space with their own rolling equipment. Foreign tank cars have had to be employed to cover demands and also for long-term use.

The oil companies have built their own fleets on the basis of the average quantity of oil to be moved. The capital necessary for larger fleets was thought to serve with better effect in the oil business itself.

These additionally required tank cars have been rented. As early as the seventies of the last century, the idea of commercial car leasing arose. At first normal wagons were leased and later on special ones, mostly tank cars. The first essential foundings of this business branch of the business took place between the end of the 19th and the first two decades of the 20th century. They met a real need of the expanding economy in Europe, especially the oil business to which a close connection developed. Since then the business of leasing tank cars has risen steadily and fulfilled functions which are necessary in a highly developed and specialized economy.

Car lessors provide reserves of carrying capacity and hence enable the lessees and consignors to save investment in means of transport. By limiting the duration of leases the oil companies limit their risk which they would have by running their own cars. Lessors on the contrary, run an economic and technical risk to a great extent such as those which have been brought about by changing tariff regulations or by technical progress. They also supply special cars of high capital cost for various cargoes and adapt their equipment to changing needs of customers and to technical development. They offer a good service to customers by quick dispatching of cars on short notice, by thorough care of the rolling equipment, and by quick repairs.

In recent years the cooperation between the petroleum industry and the lessors of tank cars has become so satisfactory that now about 40-50% of all tank cars employed for shipping oil products in Western Europe are rented. Car lessors have been willing to meet the demand for tank cars by making the large investments which were necessary after World War II and because of larger consumption, recently especially of fuel oil.

In Western Europe the leadership of the leasing branch is held by VTG Vereinigte Tanklager und Transportmittel GmbH, Hamburg, and its numerous foreign agencies, and the group led by Compagnie Auxiliaire Internationale de Chemins de Fer S.A., Brussels.

VTG, owning 14,000 modern tank cars besides large tank installations and tankers, owns the largest rolling stock. During recent years it has ordered 2,200 tank cars to be built and 3,000 tank cars to be rebuilt to meet modern technical requirements. These wagons are mostly leased to the petroleum industry of Germany and other Western European countries.

Technical development

Railroads immatriculating privately owned tank cars have always set up rules covering construction and maintenance of the cars. Concerning the European traffic there are binding regulations for all railroad administrations, i.e. the "Technische Einheit im Eisenbahnwesen (TE)," having first come into force in 1886, and the "Uebereinkommen über die gegenseitige Benutzung von Güterwagen im internationalen Verkehr (RIV)." These regulations must be applied to privately owned tank cars running on European rails. The international transport rules for dangerous goods, i.e. also for inflammable liquids are contained in the Annex I (RID) to the International Convention concerning the carriage of goods by rail (CIM)" which is applicable on January 1, 1959 in a new wording.

For a long time the chassis of the tank cars was the same as that of the normal wagons owned by railroads. They had two axles and a loading weight of 10 t in the beginning which was increased to 15, 18 and finally to 20 t as railroad lines and rolling equipment were improved. The cubic capacity of the tanks changed during this period from 15 m^3 to 19, 21 and to a maximum of 26.5 m^3. These cars were of the so-called classical construction, i.e.wagons with a chassis of shaped iron on which the tank was fixed, supported by two cradles. Special equipment for certain cargo, such as heating coils, heated outlets and insulation as well as tank compartments have been used for a long time. For certain cargo also tank cars with three, four and more axles were built to a certain extent.

The cars of classical construction had a high tare weight so that the loading weight was uneconomically low in comparison with the permitted axle load of 16 t which was generally applicable up to a few years ago. The ratio of tare weight to loaded weight was 1:1.5 for wagons of 15 m^3 and 1:1.65 for wagons of 26.5 m^3.

About 1959 a basic change in the construction of tank cars took

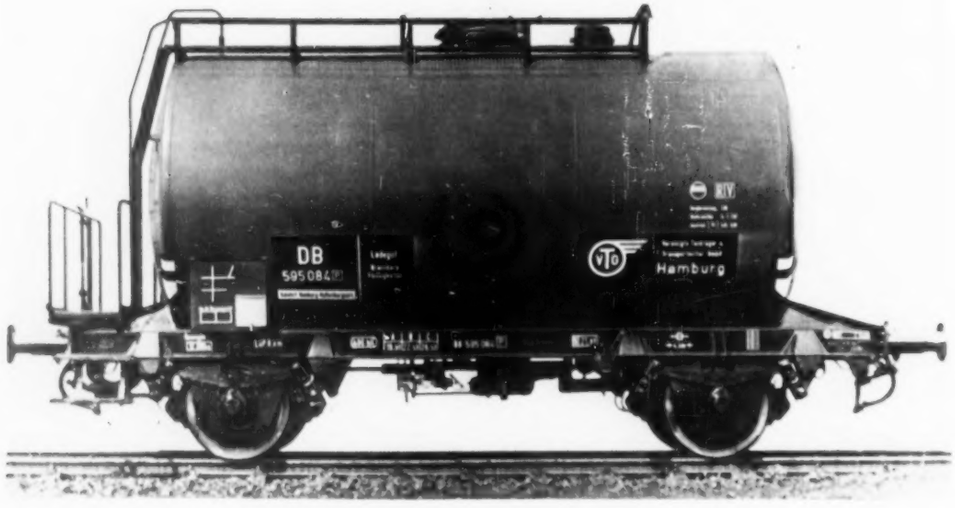


Fig. 1—Tank car, Type 22 - 40 (photo courtesy Linke-Hoffmann-Busch-Waggon, Fahrzeug-Maschinen GmbH).

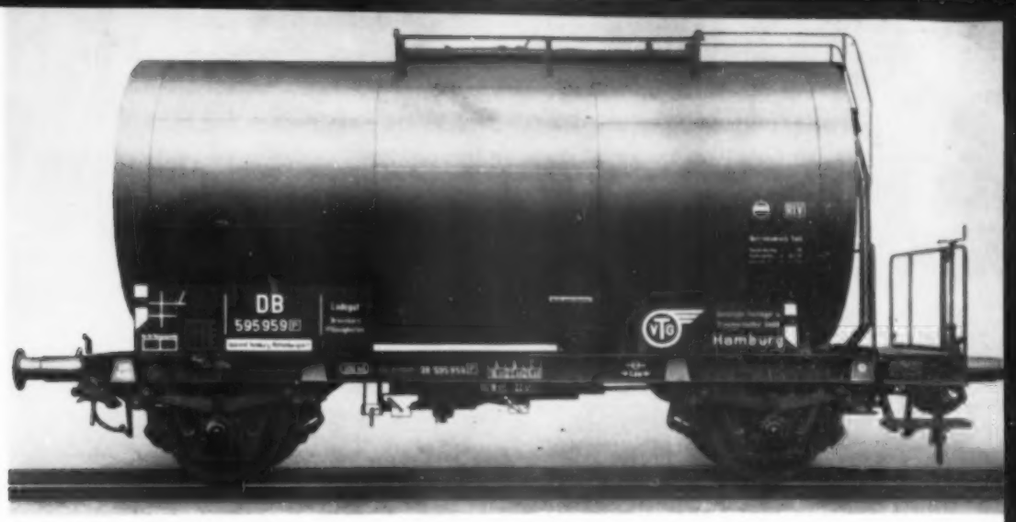


Fig. 2: Tank car, Type 69.

place by introducing "light construction." The principle of this consists in making the tank a supporting part and thus eliminating the chassis. The pushing and pulling forces are absorbed by the tank itself. This construction has prevailed in spite of doubts which still exist in the minds of some. As a result of experience, several parts have been improved. "Light construction" allows placing the tank considerably lower. Therefore, a lower center of gravity is obtained leading to better running conditions. At the same time, a larger cargo capacity can be carried.

A tank car of "light construction" with 2 axles and a capacity of 30 m^3 has a tare weight of 10 t and a loaded weight of 22 t; this results in a ratio of tare weight to loading weight of 1:2.2. Tank cars with 4 axles also have been built like this which can carry 46 t. These cars with a tare weight of 18 t and a capacity of 48 m^3 or 63 m^3 have a ratio of 1:2.55. These figures show the essential improvement of the ratio of tare weight to loading weight by "light construction."

Recent transport requirements of the oil business and the possibility of utilizing an axle load of 20 t on many lines of European railroads have caused VTG to develop a series of new types of tank cars in cooperation with Waggonfabrik Linke-Hofmann-Busch GmbH (LHB), Salzgitter-Watenstedt. The construction experience of LHB and the operating experience of VTG with its large rolling stock, comprising seventy different types of wagons, were combined profitably.

Figure 1 shows a tank car of large capacity with two axles for the conveyance of gasoline.

Cubic capacity	40 m^3
Maximum loading weight	28 t
Tare weight	12 t
Ratio tare weight : loading weight	1 : 2.33

This car was built in "light construction" with fully welded seams. It is equipped with strong front parts on both sides of the tank and with sole-bars welded to the tank and consisting of folded steel plate. This wagon has been examined on the test-stand with 200 t front pressure. The values measured at the critical points are far below the maximum admitted stresses. The characteristics established by running tests are completely satisfactory. This type of car has been very well accepted in Germany and other countries.

Figure 2 pictures a wagon with 2 axles which has been developed for current and expected demand for special tank cars for hauling heavy fuel oil.

Cubic capacity	30 m^3
Maximum loading weight	26.5 t
Tare weight	13.5 t
Heating surface	16.0 m^2
Insulation	100 mm
Ratio tare weight : loading weight	1 : 1.96

For the first time a tank car of large capacity (See Figure 3) with 4 axles has been developed for carrying warm cargo (heavy fuel oil or bitumen) with temperatures running up to 250° C.

Cubic capacity	65 m^3
Maximum loading weight	55.5 t
Tare weight	24.5 t
Heating surface	30 m^2
Insulation	100 mm
Ratio tare weight : loading weight	1 : 2.26

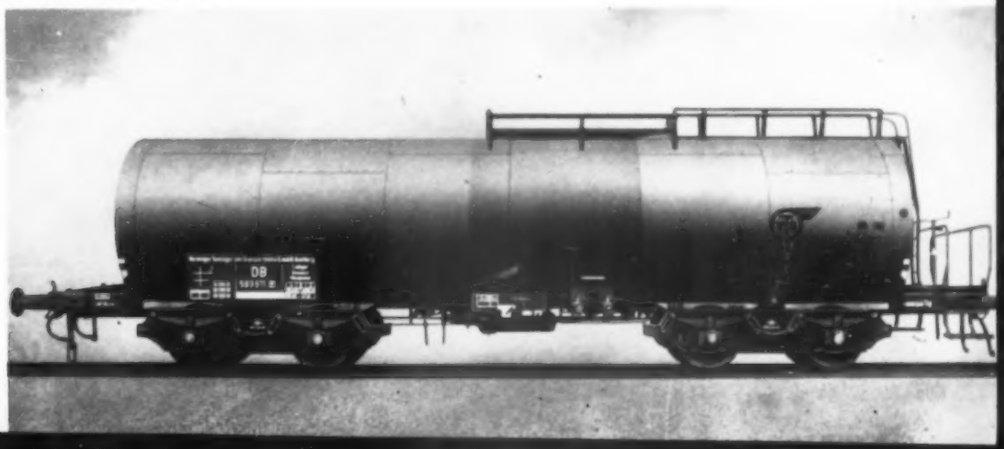
This new construction permits expansion of the 12.7 m long tank arising from the thermal influences without creating any dangerous tension and thus fully preserving the necessary stability of the whole car. Undesirable heat losses are avoided by the fact that both strong front parts also are partly insulated.

Figure 4 shows a tank car with 4 axles for the conveyance of liquefied gases such as propane, butane and ammonia. The tank has been constructed for a test pressure of 27 atm. By employing high grade special steel, the thickness of the steel plates of the tank is reduced permitting a lower car weight.

Cubic capacity	80 m^3
Maximum loading weight observing the prescribed filling weight for instance of ammonia	42.6 t
Tare weight	36 t
Ratio tare weight : loading weight	1 : 1.18
For former construction this ratio was	1 : 0.78

The technical development of tank cars and their parts or equip-

Fig. 3: Tank car, Type 89.



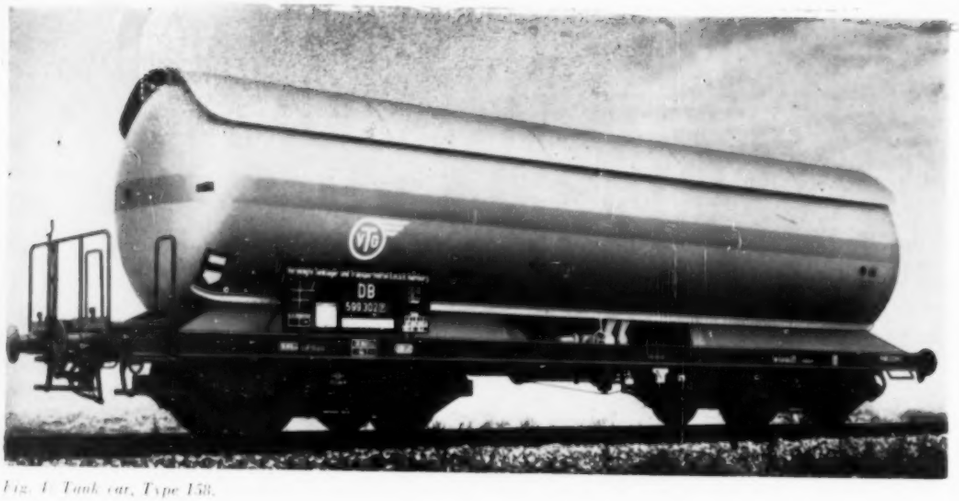


Fig. 4. Tank car, Type 153.

ment concerned with operation or safety is being thoroughly studied and influenced by users, lessors, and manufacturers in cooperation with the railroad administration. Special attention is paid to further improvement of loading capacity, heating equipment, insulation, and outlet valves as well as to economical maintenance of rolling stock. Thus, for instance, the construction of a special tank car with six axles for transporting fuel oil has been studied. It was found that this car does not offer important advantages compared to the tank cars with four axles. Besides, its employment would be limited because of its extraordinary measurements etc. which would not fit present equipment at filling and discharging stations.

Some time ago at the suggestion of VTG, studies were made of tank baffles which are still required by railroads in tank cars. The result was that baffles may be abandoned without injuring the safety of railroad operations or the stability of the tanks. An application has been handed to UIC asking its consent to the abolition of the baffles reducing the costs for construction and especially for maintenance of tank cars. Furthermore VTG is studying the employment of plastic tanks for the transport of liquids.

The technical description of railroad rolling stock required by the petroleum industry should not be terminated without pointing out that UIC compulsory technical regulations for the construction of wagons are being reconciled serving for the standardization of the construction of tank cars, too.

Present and future position of railroad tank cars

The position of railroad tank cars has changed since the transportation monopoly of the railroads was abandoned by dividing inland traffic between rails, waterways, and roads. In rebuilding the European economy since World War II this change of structure has become more and more significant. The quantities of mineral oil to be transported grew as consumption expanded and larger transport units were required to reduce shipping costs. Large new tank stations were built on waterways which were being made navigable only now and existing tank installations were enlarged. For distribution of mineral oil products in short-distance traffic as well as for long-distance service, road tank trucks were employed to an increasing extent. Also traffic of mineral oil products by rail increased, but its degree of expansion was lower than for other carriers. The German situation is represented by following dates (expressed by indexes):

	Rail	*Inland navigation*	*Professional long-distance road service*	
1936	100	100	1933	100
1954	155.7	246.8		398.4
1955	171.9	308.1		677.2
1956	190.7	382.7		945.0
1957	185.3	459.1		1105.2

In other countries the advance of road tank trucks may be even more obvious.

Railroad tank cars as means of transportation of mineral oil still are important, but their position in total traffic is not as great as would be desirable and it does not now correspond to the importance of the railroads in the European economy.

The increasing demand for energy which has been taken into account by the European petroleum industry by construction of new refineries and further projects now planned will increase the quantities of oil to be transported within the next few years. Requirements have brought about the decision to supply refineries with crude oil by pipelines at moderate costs. The pipeline from Wilhelmshaven to the Rhein-Ruhr district was opened at the beginning of 1959. It has been decided to lay a pipeline from Rotterdam to Godorf (between Cologne and Bonn). The proposed pipeline from Marseille to Strassburg and Karlsruhe (perhaps with a connection to the Rotterdam-Godorf pipeline) is now being designed. The railroad tank car is not affected by these projects because imported crude oil has never been transported by rail and such large quantities cannot be forwarded by railroad.

The only noteworthy European pipeline used for refinery products in civil traffic is the Le Harve-Paris pipeline. It cannot be said with assurance at this time that other product pipelines will be operated in Europe, but the possibility has to be taken into consideration. The employment of railroad tank cars would be affected by these pipelines which may traverse districts the supply of which was previously served by rail.

New refineries are being constructed near centers of consumption. Therefore, the distance of transport for distribution of products are being diminished and carrying capacity can be saved. On the other hand, the quantities to be forwarded are increasing so that a greater demand of railroad tank cars and road tank trucks may be expected. It is possible that more products than now will be transported directly from new refineries to the inland distribution centers and to consumers. This might be done in the case of medium and heavy fuel oil because hot cargo to be filled into insulated special railroad tank cars will reach the customer still in fluid condition. Casts for transshipment and required re-heating of the cargo will be saved in this way.

The predicted development of consumption, the possibility of choosing a properly equipped type of tank car for each oil product and of distributing reliably even during difficult atmospheric conditions, all these facts justify the supposition that also in future the railroad tank cars will have an important position in oil traffic and as it is hoped, even a better one than at present. It will depend on the tariff arrangements of railroads how far these hopes of increasing tank car employment will become true. But also the level of mileage allowance (redavance) which is granted by railroads for consignments in privately owned tank cars is important in this respect. At the present time the private owner's allowance is not sufficient.

VTG
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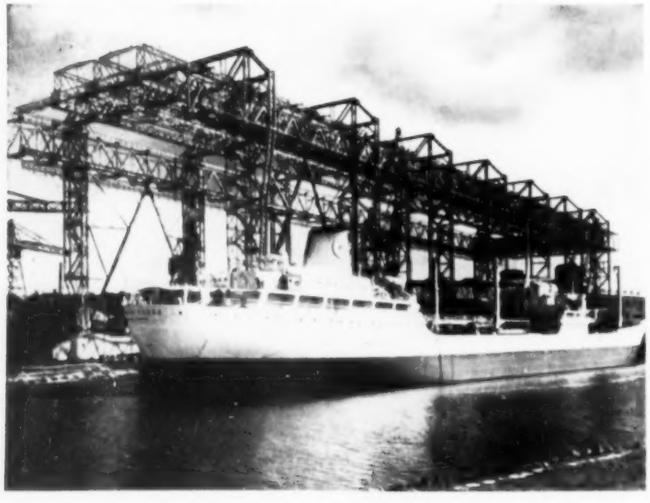
Latest aspects in super-tanker design

by Dr. h.c. H. W. Schliephake, Director of Krupp-Werft A.G. "Weser"

INCREASING world demand for crude oil and petroleum products has caused a great deal of hard thinking in the shipbuilding industry to devise means of meeting transportation requirements inherent in this development. It is for economic considerations that the vessels have progressively grown to tremendous sizes during the last ten years. However, in view of the presently available port installations and existing water depths (for example the Suez Canal) 100,000 dwt tankers now under construction can be used on certain definite routes only. Nevertheless, the construction of still larger vessels has been discussed in trade journals.

The alternative transportation of ore and crude has materialized with the advent of the combination ore oil vessels. These offer the possibility of saving valuable time by avoiding or cutting ballast runs.

Tanker at AG "Weser" dockyards at Bremen.



Similar to the tanker pattern, propelling machinery is housed in the stern.

In the field of super-tanker building, shipyards are faced with special problems from the standpoint of both design and assembly. A 38,000 dwt tanker is almost as long as 200 meters (660 ft.) and the stability of the hull deserves particular attention. Among other problems, technological considerations cast suspicion on the soundness of welds on plates over $1^1/_2$", and the classification societies have issued limiting rules on this subject which must be complied with.

Any shipyard contemplating the building of large-size and super-tankers should preferably have gathered adequate previous experience in the construction of smaller tankers. Like other shipbuilding interests, the Aktiengesellschaft "Weser" at Bremen, Germany, a subsidiary of the Krupp concern, looks back on a progressive change from smaller vessels to super-tankers.

Latest developments in marine engineering science are employed for molding the vessel so as to achieve favorable propulsion conditions and good seagoing abilities. Model tests made in the testing laboratories of the shipbuilding industry provide the basic factors to make sure that the propelling machinery to be installed will definitely be adequate to obtain the trial speed required by the shipowner. In general, the trial speed of present day large size tankers varies from 16 to 18 nautical miles per hour.

The ship's steel frame is designed along the rules and principles published by the classification societies whose functions include surveys at the time of construction. The loading tank space of tankers up to 65,000 dwt is subdivided at 12-meter intervals by transverse bulkheads and by one longitudinal bulkhead on either side while still larger tankers require an additional longitudinal center bulkhead. Shipbuilders have largely discarded in recent years the arrangement of pump compartments within the loading space. They now prefer the installation of the oil transfer pumps in the area between the machinery space in the stern and the loading tanks. The forecastle embraces a compartment for auxiliary pumps.

Anchor-, towline- and loading winches are steam operated because spark formation on electrical machinery might cause explosions. Suitable oil hose handling facilities are provided in the area of deck connections for oil loading and unloading. Pressure equalizing in the loading tanks is ensured through vent lines which are grouped and routed up on superstructure masts and columns. The steel or light metal life boats on either side of the vessel are sized to provide

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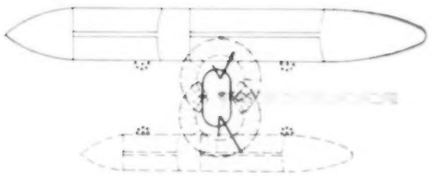
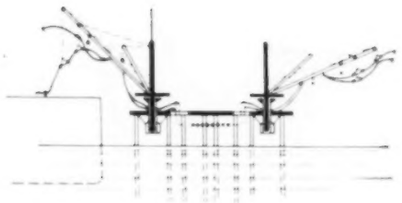
sufficient space for the whole crew. Design of the entire equipment is guided by the principles of usefulness and safety.

In view of the short turn-arounds which are quite common today, sailors have little chance to leave the ship; therefore, accommodation facilities for the crew are equipped with every possible comfort. With few exceptions, all ranks have single berths. In addition, separate sitting rooms and bedrooms are available to senior officers. A sufficient number of messes and day rooms are also available. Particularly liberal standards are often applied to sanitary facilities, some officer ranks have at their disposal separate lavatories including tub or shower and WC. All sitting rooms, day rooms, food stores and kitchen rooms, and sanitary rooms are fan-ventilated. Air conditioning is increasingly provided for sitting rooms and day rooms. Materials which are fireproof or not easily inflammable are used to a growing extent in order to improve on fire safety.

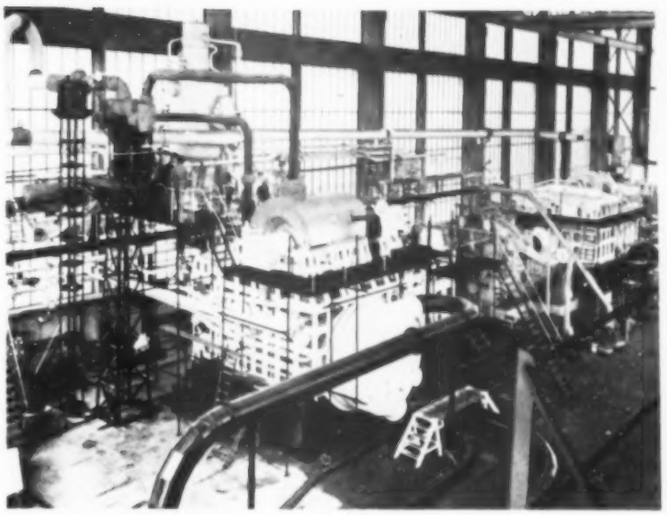
Modern navigation instruments including radar, radio compass, sonic depth finder, speed indicator, automatic steering system etc., are installed. Especially on larger tankers, television is likely to enter into the field of navigation in the near future because shipbuilders show an increasing tendency to move the bridge from amidships to the stern super-structures. A television camera on the forecastle and a receiver on the bridge at the rear end of the ship would be a substantial contribution to safe navigation.





Plan and elevation of modern tanker loading installation.

The tankers under review are exclusively propelled by high pressure steam turbines designed and built by the shipyard. The advantages of steam plants include easy supervision and attendance. In addition, steam requirements for cleaning tanks, maintaining cargo temperature and for kitchen needs are met by the main boilers while a separate steam generating plant must be provided for these purposes on ships with engine propulsion. Design of the machinery incorporates the latest developments. For the smaller ratings (7,000 Shp and 10,000 Shp) live steam conditions are 34 and 45 atm.g. boiler drum pressure at 400 and 460° C steam temperature at the superheater outlet while the figures for higher ratings (12,000, 16,000 and 17,300 Shp) are 62 atm.g. boiler drum pressure and max. 480° C steam temperature at the superheater outlet. A specific fuel oil consumption of 283 gr. Shp at a rating of 7,000 Shp down to 230 gr. Shp has been measured under these operating conditions. These consumption figures do not refer—as is usual for engines—to the



Geared turbines under test. In foreground 12,500 shp unit.

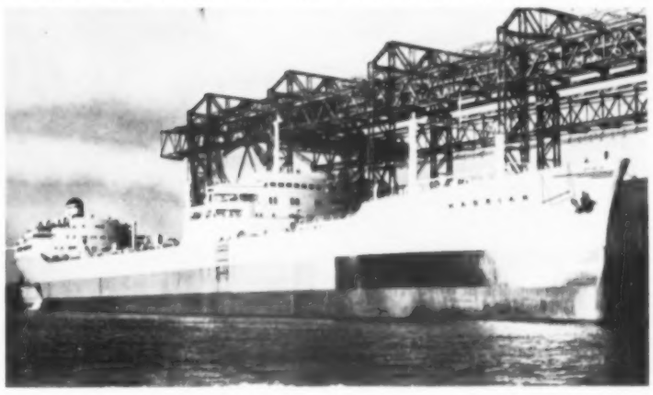
actual output at the turbine coupling only, but to the power transmitted to the propeller at the stern bulkhead and they include any further power consumption for propulsion purposes and operation of the vessel, including steering engine, illumination, navigation and kitchen service for the crew (during normal cruising). The figures indicate that the efficiency of the machinery has been substantially improved during the period under review. Two main factors account for this improvement: the progressive change to larger vessels of greater capacity per unit, and the progress made in the design of the machinery itself.

The main propulsion units consist of a high- and a low-pressure turbine which includes the astern turbine. A double-reduction gear serves for the power transmission from the two turbines to the propeller shaft whose speed is approximately 100 rpm in all cases. Two oil fired water-tube boilers with automatic control are installed for steam supply. Feed water is heat exchanged with extraction steam for preheating.

Electric power is supplied from three phase turbo alternators only. Steam for kitchen and heating purposes is taken from steam desuperheaters. The turbine-driven oil transfer pumps are sized to achieve an average unloading time of 10 hours for the entire load.

Most of the essential components of the propulsion machinery and electrical equipment including boilers, turbines, gear units, turbo-alternators, oil transfer pumps, turbine driven feed pumps, heat exchangers, master switchboard, electrical distribution centers etc. are fabricated in the yard shops along own designs which are the result of many years of experience and development work in this field.

Turbine driven tanker being fitted out for delivery by "A" ever."



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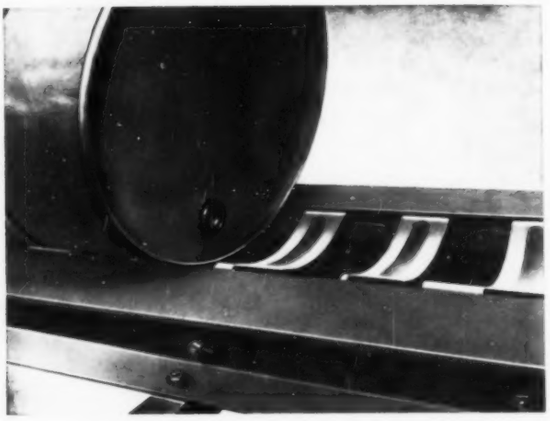
Chain conveyors for barrel transport



Details of barrel transport equipment for horizontal barrels. For vertical barrels a different arrangement is necessary. (Picture by Siemag Werk-Photo)

NOT ONLY at drilling rigs, but also in big refineries, there are running, year out and year in, steel sprocket chains that have to stand up to exacting conditions and heavy loads that must be considered when planning new installations. A large proportion of the products that originate in a refinery are put in barrels for shipment. The barrel is indeed an ideal form of package, but on account of its weight, it is not easy to transport. The larger the output of the products, the more it is necessary to assure that the transport system shall operate efficiently. Therefore, big refineries are making successful use of transport equipment that smoothly brings empty barrels to the filling stations and carry the full barrels to storage or to the loading station—as far as possible automatically.

The principal element in these installations is the conveyor chain. The conveying operation stands or falls according to how it functions. A chain belt consists of two single chains which are joined together by specially shaped traverses to form the whole belt. The form of these traverses depends on whether the barrels are carried horizontally or upright. In order to visualize how such an outfit may look, we give below the data of an installation set up during 1955. The chains and chain wheels produced by a well known West German firm—the Siemag Feinmechanische Werke GmbH, Eiserfeld/Sieg (a subsidiary of the Siemag Corporation that is specialized in the manufacture of rolling mills and mining installations).

Here are the principal data: The complete installation consists of 16 conveyor lines with a total length of more than 3,200 feet (or 960 meters). These conveyors have different lengths; the longest has 234 feet (70 meters). The chain speed comes to 60 feet per minute or 0.3 meter per second. The capacity is eight barrels a minute. The installation runs for 16 hours a day.

These data allow one to form a technical idea of the installation, but to perceive its full significance requires further thought. From the middle of 1955 to the end of 1958 the chain belts, operating 16 hours a day, have moved about 9,800,000 barrels. This corresponds to a weight of 1,660,000,000 kilograms or 3,640,000,000 pounds. Each of the 16 driving sprockets revolved 8,250,000 times during the $3\frac{1}{2}$-year period of operation. This will give an idea of the magnitude of the task that was imposed on the chain belt barrel transport system.

As regards the chains themselves, which function as both hauling and load bearing elements, the main fact is that they are subject to a heavy load in the hauling direction, and consequently, all parts had to be highly resistant to wear, which also affected the bearing rollers as well as the chains.

These chains consist of side bars, pins, bushings, and bearing rollers. The side bars which together with the pins and bushings from the outer and inner members, are made of a specially heat treated steel whose normal strength lies between 70 and 85 kg mm^2 or 100,000 and 120,000 psi. The strength may be increased up to 100 kg cm^2 or 145,000 psi, respectively, and more in case of need. The pins and bushings form the joints. In order to give them extra resistance to wear, they are case-hardened (cemented). The rollers are heat treated to increase their resistance to wear.

An especially severe condition imposed on the chain conveyors is due to the fact that they are mounted out of doors. Even with excellent attention (lubrication) the weather may leave its mark on the chains; in tropical locations the installation may be fouled with dirt and flying sand. In spite of all this, and in order that the conveyor may operate freely, the choice of the clearance in the joints and in the rollers is important. In the installation of such facilities it will be wise to make use of the many years of experience of chain manufacturers.

A transport problem in a big refinery: Many barrels, filled and empty, have to be moved. The picture shows a belt for barrel transport. To counteract the high corrosion danger, the West German firm of Siemag coats the traverse plates of the belt with a protective layer of bitumen applied by flame-spraying, using the Colarit process.

SIEMAG ROLLER CHAINS

Siemag Standard ASA roller chains are operating on many drilling rigs throughout the world. They have demonstrated their workability in all climates and under the most difficult conditions.

SIEMAG CONVEYOR CHAINS

Siemag conveyor chains have been installed in many conveying systems and in different designs are rendering excellent service in the transport of oil-barrels.

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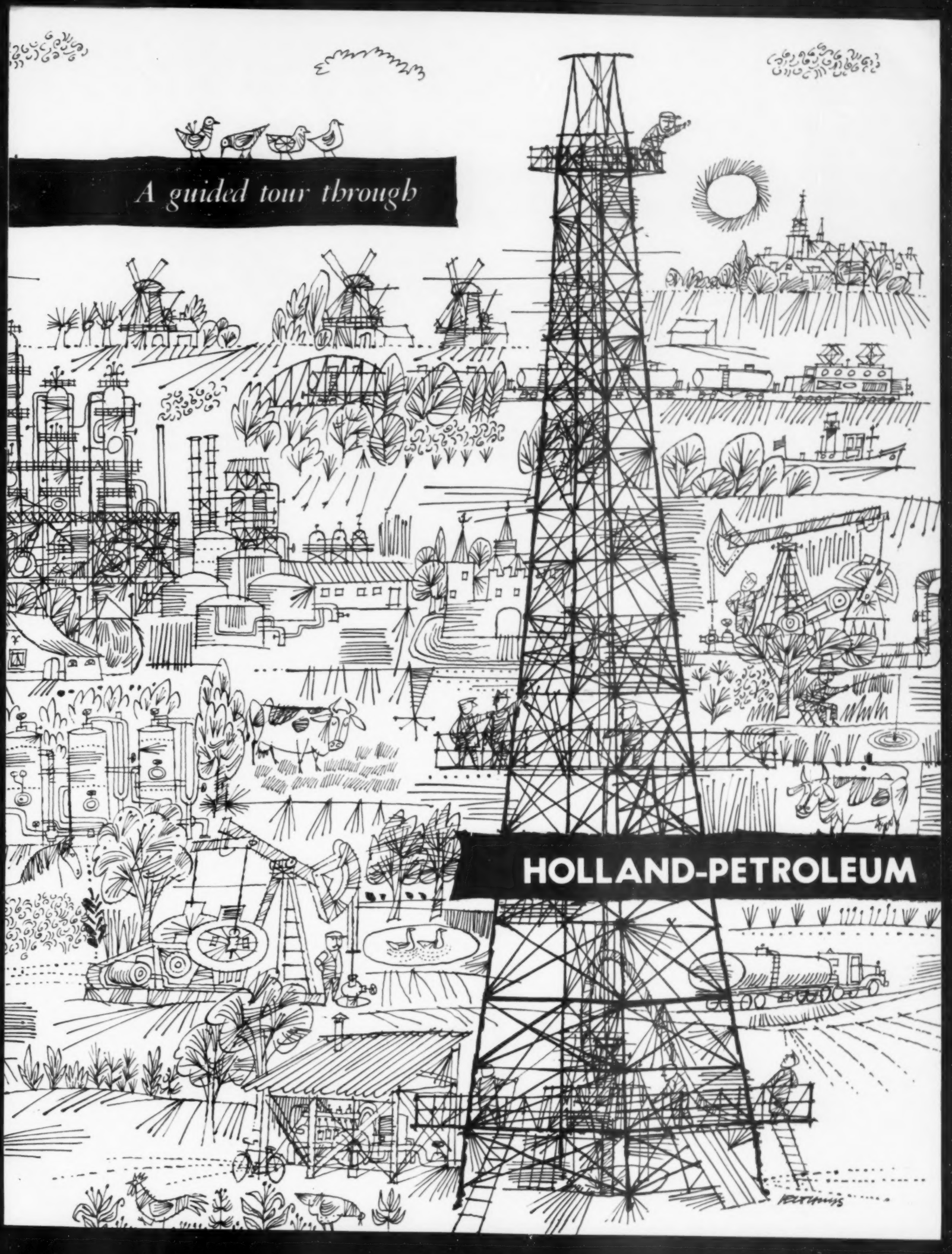
A guided tour through
HOLLAND-PETROLEUM

A small country with 11 million inhabitants. The Netherlands can point to a long and intimate involvement with the oil business.

The beginning was modest: oil was imported from the island of Sumatra and sold all over Europe for the only purpose known in those days—as a universal medicine. Towards the end of last century the Royal Dutch Petroleum Company was founded and started operations in the East Indian Archipelago. Its history faithfully reflects the entire development of the petroleum industry, in which, after fusion with the Shell Transport and Trading Company, it has become one of the major groups. Its activities have made Holland oil minded, and have given the country a prominent place in the oil world.

Today the Netherlands' output of crude oil is very high indeed. A production of 10,000,000 bbls annually has been reached by the "Nederlandse Aardolie Mij." (Shell-Esso interests): $400,000,000 worth of petroleum products and petrochemicals from Dutch refineries are being exported (Shell, Caltex and soon: Esso). Substantial contributions to knowledge about oil and its technology have come from this country:

—the first Diesel-engined tanker
—the stabilizer for natural gasoline
—the first Diesel driven rotary rig with hydraulic coupling
—the alkylation process for manufacturing iso-octane
—tools for evaluating oil products (the CFR diesel engine, the four ball E.P. lubricant tester)
—new lubricants that have made diesel engine operation on heavy fuel oil economical for ships

As a result of the activities of the oil companies, the Dutch industry in general has acquired considerable experience in manufacturing oil equipment; "Made-in-Holland" equipment supplied to the oil industry is valued at another estimated $400,000,000 a year.

This, in turn, has drawn other oil companies and contractors to Holland (Aramco). They choose to conduct their foreign operations from this country, knowing that they would find both a hospitable industrial climate and a great deal of specialized know-how and technical skill.

Most Dutch equipment manufacturers are united in a business promotion group, the "Netherlands Oil Equipment Manufacturers", sponsors of this Holland section of WORLD PETROLEUM. The N.O.E.M. gladly joins the publishers in expressing their best wishes for the success of the 5th World Petroleum Congress, to which this special issue is devoted.

Ir. C. J. Indriessen
President, Netherlands Oil Equipment Manufacturers

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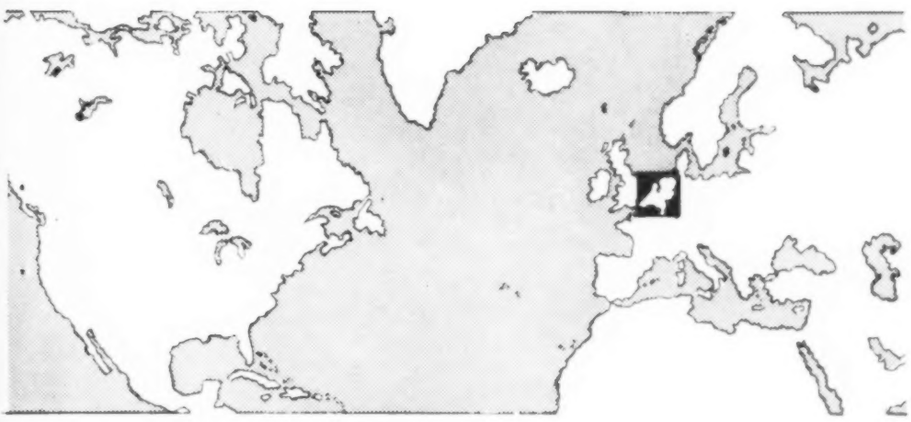
Holland and its oil



The compendium issued under this heading is the result of a close co-operation between leading officers of the various oil companies working in Holland, amongst which are mentioned the producers of domestic oil and gas, the Netherlands Petroleum Company (N.A.M.—a subsidiary of Royal Dutch Shell and Jersey), the Caltex, Shell and Esso Refineries at Pernis, as well as the leading marketing companies such as Shell Netherlands, Esso Netherlands, Caltex, the tanker companies of Shell, Caltex and Esso, the Rotterdam-Rhine Pipeline company and the research organizations of Shell and Caltex.

The introductory chapter was written by Dr. P. Schierbeek; chapter III was contributed by Mr. Ch. A. Hofman.

The compendium was edited under the responsibility of Dr. H. A. Stheeman and Dr. H. ter Meulen.

The energy position in the Netherlands . . . and the place of oil in it

As an introduction to this compendium of various aspects of the Netherlands oil situation, a background picture is given here of the general energy position in the country, from which the place oil occupies in it can clearly be seen.

The following figures, taken from the Government Note put before Parliament in 1957 on the possibilities in the Netherlands of using nuclear energy for the production of electricity, will make a good starting point.

	1937	*1955*	*1975*
	(in million tons coal equivalent)		
Consumption	15.5	26.0	43.0
Coal production	14.4	12.0	12.0
Oil and natural gas production	—	1.7	2.1
Coverage of consumption by own production	93%	53%	33%

(Bunker oil and coal are not included in these figures)

It should be pointed out, however, that the figures for 1975 have no absolute value, as they only represent estimated expectations.

Coverage of Consumption

In the case of "Little Europe"—comprising the six Common Market, Coal and Steel Community and Euratom countries, including the Netherlands—the corresponding coverage figure will drop from 77% in 1955 to a level of about 60% in 1975. For the seventeen O. E. E. C. countries the respective percentages are 80 and 75.

When converted to primary energy raw materials the Netherlands energy requirements are covered about two-thirds by solid and one-third by liquid fuel. It may, however, be taken for granted that this proportion will change in the coming years in favor of liquid fuel, although it is difficult to forecast at what speed this substitution will take place; for in addition to technical factors, the policy of the producers of power will play a very important role.

Dr. P. Schierbeek, Director for Nuclear Energy at the Ministry of Economic Affairs, Government representative on the Board of Directors of N.A.M. and lecturer in Mining Law at Delft University.

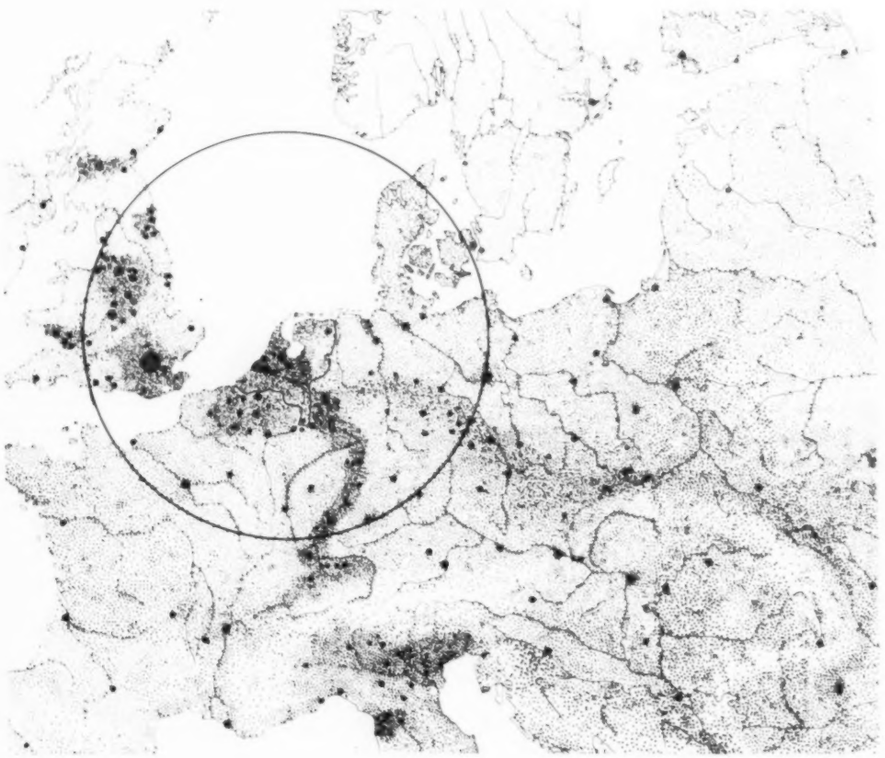
Mr. Ch.A. Hotman, Managing Director of the State Gas Service.

Dr. H. A. Stheeman, General Manager of the Netherlands Petroleum Company and president of the Dutch delegation to the World Petroleum Congress.

Dr. H. ter Meulen, Assistant Coordinator of the Manufacturing group at the head office of the Royal Dutch Shell (KPM), in The Hague, formerly Managing Director of the Curaçao Petroleum Industry Company and member of the Permanent Council of the World Petroleum Congress.

This map which reflected the relative density of population in North Western Europe in 1955 still holds good at present in so far it depicts the situation of the Netherlands at the embouchure of the densely populated Rhine valley. (by courtesy of Rijksdienst voor het Nationale Plan)

- *5,000 inhabitants*
- *cities of more than 100,000 inhabitants*
- approx. 25 inhabitants per square mile
- approx. 125 inhabitants per square mile
- approx. 500 inhabitants per square mile



The favorable geographical location of the Netherlands has given this country a key position in the increasing importation of raw materials for West-European energy. The ever growing concentration of oil refineries near Rotterdam has no equal in Europe; 450,000 barrels a day is the anticipated output of these refineries. This, added to its situation by the second largest port in the world, which is making it the coal, ore and oil terminal for Western Europe, is of inestimable significance to the Netherlands economy.

In the first place, there is the export of refined oil products; secondly, the bunkering of ocean-going vessels; and thirdly, its stimulating influence on Dutch trade and industry. In this connection, too, it is not only the oil industry itself which is of such importance, but also the many orders that flow to other Dutch industrial enterprises for the maintenance and expansion of refineries. There is also the new petrochemical branch, already well established but certain to increase both in size and significance, with the aid of the existing chemical industry based on coal, salt and sulfuric acid. And finally, the oil industry fosters an export position of no small significance for those other Dutch industries making oil equipment of all kinds.

Then, too, in Little Europe account will have to be taken in the future of the possibility of a coordinated energy policy, proposals for which the Supreme Authority of the Coal and Steel Community is now working out for the Council of Ministers of the six member countries. The high cost of coal production in Western Europe and the fluctuating ocean freight rates for United States coal will make it difficult to cover the rapidly increasing demand for energy in any other way than by raising oil imports. Nuclear energy will certainly not be of dominant influence on the total import needs of the raw materials for conventional energy supply, at least up to 1975. For that year it is estimated that the Netherlands will have to import over 25 million tons of crude oil in coal equivalent, which will then represent almost 90% of the imports of conventional fuel. The Netherlands may count itself fortunate in being able to obtain oil from within its own borders, first due to the thorough prospecting carried out by the B. P. M. whose task was later taken over by the N. V. Nederlandse Aardolie Maatschappij (Netherlands Petroleum Company), in which the Royal Dutch Shell Group and the Standard Oil Company of New Jersey each have an equal interest. From this source, and despite the increased demand, about 25% of the total domestic needs of oil products is covered by national production. And although compared with the total energy requirements, the production of natural gas is as yet of little consequence, it has caused a minor revolution in the national supply by largely replacing coal gas for municipal use.

This, however, constitutes only one of the factors to which the increase in Netherlands power consumption can be attributed. For side by side with the industrial relationship there is the other important feature of the rapid increase in the country's population. Between 1937 and 1955 this rose from 8,600,000 to 10,700,000 inhabitants and by 1957 had already topped the 11,000,000 mark. By 1975 the estimated figure is about 13,500,000. Such a rapid population increase in such a short time has naturally a very stimulating influence and effect on the whole industrial development. The continuous trend of general technical development towards new methods and automation, coupled with the growing prosperity per head of the population, will actually lead to a higher demand and need for energy than would proportionately arise from the steady increase of population alone.

The Netherlands energy and power requirements will to a large and ever-increasing extent be based on imports of oil, and owing to the fortunate accident of geographical location, this will prove a stimulus to the national economy which will gain momentum by the establishment and operation of the European Common Market.

Oil and gas production in the Netherlands

A. Geology and exploration

I. *Synopsis and historical review*
(cf. Sketch map below.)

The Netherlands, with the exception of the extreme southeastern tip, are almost completely covered by flat-lying fluviatile and glacial deposits of Quarternary age. Also the underlying Tertiary, locally up to 7,000 feet thick, has hardly experienced any tilting or folding. Both unconformably overlie the older formations. Knowledge of the latter was only obtained after coal mining started in the last century in the southeastern corner of the country and considerably amplified since geophysical means became available to explore the deeper substratum. Plans to apply these methods were discussed in principle with the Government as early as 1932. Gravity exploration actually started in 1935 and results correlated with data obtained from a number of shallow reconnaissance wells drilled from 1937 onwards. This campaign yielded its first oil in Schoonebeek in 1943. In the western Netherlands the first economic production was not encountered until 1953 at Rijswijk, after gravity surveys had been superseded by seismic surveys, mostly reflection shooting. Considering the size of the country (12,700 square miles), Dutch crude oil production rose rapidly from almost zero at the end of World War II in 1945 to almost 14,000 b d in 1950. Since 1952 production has risen continuously to an average of 31,000 b d in 1958. One-third of this production came from the western fields of the Netherlands, the remainder still originating from the main producing field, Schoonebeek, in the east. (See chart p. 10.)

Oil traces were first encountered by the government geological survey in shallow borings in the south of the country, round about World War I, but they passed almost unnoticed. Quite a stir was made in 1924 by a find in a borehole near Winterswijk in the eastern part of the country at a time when the development of economic oil production in the region of Hanover, the discovery of Arabian oil and the development of the torsion balance greatly altered geologists' conceptions, enhancing the oil prospects of a country like the Netherlands.

Strangely enough both oil finds mentioned in the preceding paragraph were made in hitherto unproductive formations. Most of the oil seepages found in Winterswijk occurred in the Carboniferous, in which formation oil-impregnated concretions were discovered in the State coal-mines, without the Carboniferous having so far yielded any commercial production.

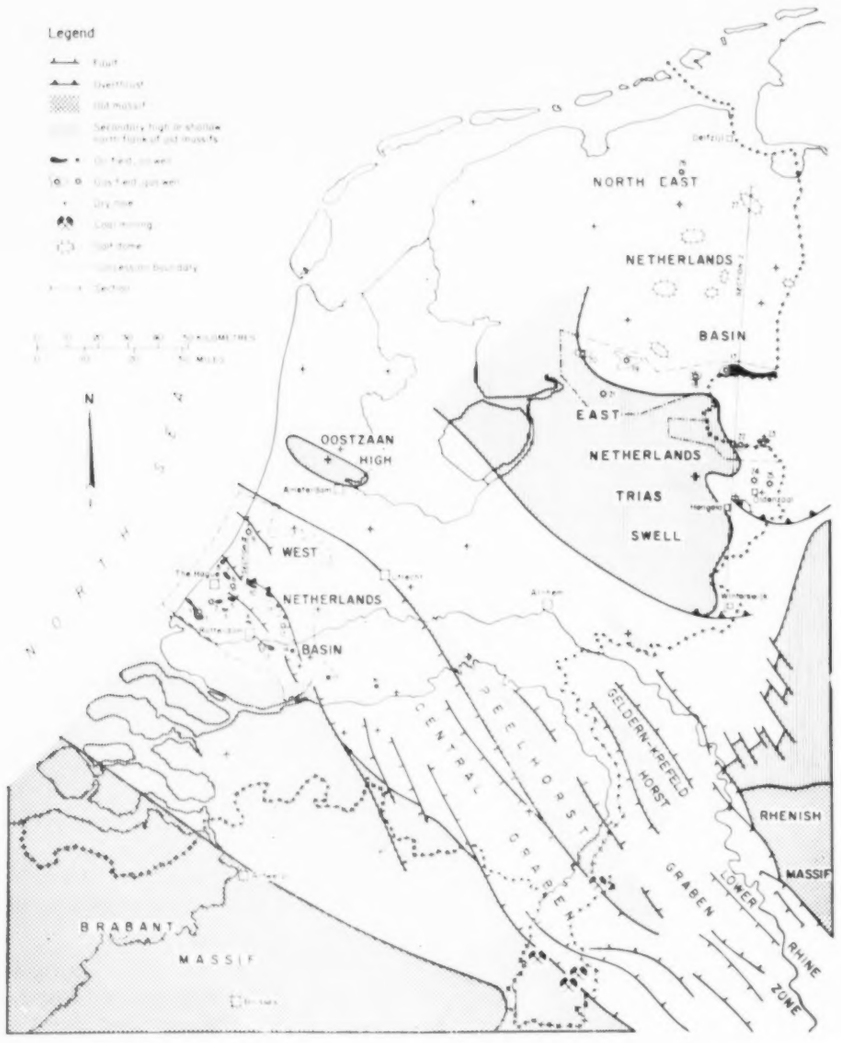
The intensive search carried out since 1935 in the formations lying between Carboniferous and Tertiary yielded a few basic facts.

In the first place, two possible oil source rocks were encountered, the lower one in the Permian (the copper shale and some Dolomites) and the upper one in the Jurassic (Liassic epsilon).

Secondly, reservoir rocks were encountered consisting mainly of broken Dolomites in the Permian or of sand and sandstones in Dogger and lower Cretaceous.

Thirdly, sealing formations were found to consist of either salt or anhydrite covering the Dolomites in the Permian, or marine and brackish shales covering the sands in the Lower Cretaceous.

Fourthly, it was discovered that in principle two main periods of tilting and folding either affected the location of accumulations or alternatively caused the migration and sometimes the dispersal of hydrocarbons: namely the old Kimmeric phase at the end of the Triassic and the Laramic phase of ◄



Geological sketch map of the Netherlands showing location of oil and gas fields and wildcat tests.

Western Netherlands
1. *De Lier—Monster*
2. *Rijswijk*
3. *Delft*
4. *Berkel*
5. *Pijnacker*
6. *Leidschendam*
7. *Wassenaar*
8. *Meiendel*
9. *Noordwijk*
10. *Zoetermeer*
11. *Moerkapelle*
12. *Nieuwerkerk*
13. *IJsselmonde—Ridderkerk*
14. *Vlaardingen*
15. *Werkendam*
16. *Andel*

Eastern Netherlands
17. *Schoonebeek*
18. *Coevorden*
19. *De Wijk*
20. *Wanneperveen*
21. *Staphorst*
22. *Tubbergen*
23. *Denekamp*
24. *Rossum*
25. *De Lutte*
26. *Ten Boer*
27. *Winschoten—Saltdome*

folding and faulting at the close of the Cretaceous. From a geological standpoint another phase, the young Kimmeric occurring at the close of the Dogger, proved to be of great importance, especially for the tectonics of the country. A tectonic feature which in former publications has sometimes been called the mid-Netherlands ridge, but which in essence presents the complex remnants of a foundered high then came into being, separating the two oil-bearing basins in respectively east and west.

Fifthly, a feature should be mentioned which in the eastern oil-bearing basin proved to be of paramount importance; a short period of uplift and erosion followed by transgressive deposition of sealing, marine formations occurring in Hauterivian time in the western and in Albian time in the eastern basin. As a consequence Schoonebeek oil field where Albian clays rest on Valanginian sands, is not only an anticlinal but also a stratigraphic trap. The effect of the Hauterivian transgression in the western basin on the distribution of oil accumulations is as yet unclear but for completeness' sake it should be mentioned that this transgression has been observed in several oil fields such as Rijswijk, Wassenaar, Pijnacker and Zoetermeer, with oil-saturated sands directly above and below the transgression plane.

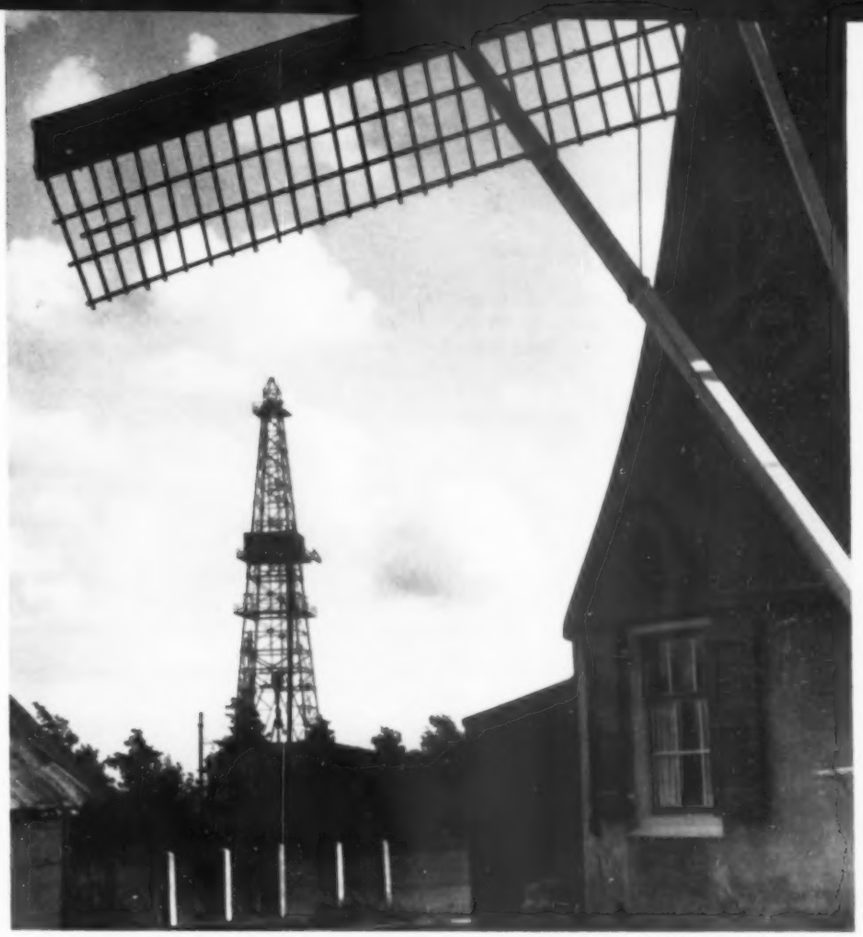
Finally, it may be mentioned that in consequence the Netherlands possess one mainly gas-bearing Permian basin in the northeastern part of the country and two Jurassic Lower Cretaceous basins which are mainly oil-bearing; the most easterly of these constitutes in reality a westward extension of the adjoining Hanoverian basin, and the most westerly represents the coastal penetration of a basin covering part of the North Sea shelf.

In the Permian basin ten gas bearing structures were found, whilst five structures were condemned besides two unproductive salt domes (Schoonlo, Winschoten). The latter two domes, however, are an important find as they gave rise to the erection of a salt and soda works at Delfzijl.

The fact that in this basin gas migrated into younger formations is not taken as a reason to classify such fields under any other heading. When taking this view, the eastern Cretaceous basin yielded three oil bearing structures only, including the prolific Schoonebeek field; four structures were found to be non-productive.

In the western Cretaceous basin eight oil bearing structures were found and four yield gas as well as oil, whilst up to now three structures have been found to contain gas only. On the other side of the balance, there are six nonproductive structures.

In the west the best prospects were encountered southeast of Rotterdam (IJsselmonde Ridderkerk anticline) and along the northern boundary of The Hague (Wassenaar field) which are now producing some 4,000 b d each.



Drilling in the land of water and windmills

The Upper Cretaceous, which partly unconformably overlies the older rocks of various ages, has in the main developed as rather porous chalky beds offering no prospects as far as can be seen at present. Also the Tertiary, consisting as it does largely of porous sandy sediments, can hardly offer any prospects. Besides some asphaltic oil traces which can be considered as fossil seepages, only one small gas accumulation was found near its base.

The above gives a rough outline of the existing oil and gas prospects in the Netherlands. The problem of making good use of these mineral resources is a chapter in itself, which will be dealt with later. Suffice it to say at this point that building up a highly-trained local staff and ensuring safe working conditions, together with the application of the most modern equipment and methods, constituted a problem which presented as many difficulties as the complicated geological subsoil itself.

II. *Geological formations older than the Cretaceous.*

a. Cambrian, Silurian, Devonian and Carboniferous. Cambro-Silurian and Devonian rocks have never been penetrated either in mines or by the bit within Dutch territory. Both, however, crop out in Belgium (the Brabant Massif and the Ardennes) as well as in Germany. Their value for our present purpose is still questionable, as is the Carboniferous which, besides having been explored and exploited in coal mines, has been penetrated in a number of exploration wells in different parts of the country. Various coal seams have been encountered, information on which is automatically passed on to the Netherlands Geological Survey. Only in one case was some gas production obtained in the Carboniferous, the accumulation occurring along a transgression plane. Exactly the same applies to the Lower Permian, developed as the well-known sandy and conglomeratic "Rotliegend."

b. The Permian. The formation of an important basin (cf. Section I). During the Lower Permian erosional products derived from the Hercynian mountains further to the south were spread over the country. Fluvial and lacustrine environments must have prevailed. The Zechstein, however, ushered in a sequence of important geological events enabling the Netherlands to rank nowadays after Italy, France, Germany and Austria as the most important gas producing country of Western Europe. After the continental phase of the "Rotliegend" Northwestern Europe was invaded by the sea and a definite trough was formed in the northeastern part of the Netherlands. The northwestern entrance of this inland sea, which entrance was situated somewhere between Scotland and Norway, was probably either narrow and shallow or totally closed for part of the time, whilst a hot and dry climate caused heavy evaporation leading to the fourfold cyclic deposition of thick Zechstein. The four well known cyclothems are well developed in the eastern Netherlands, where thick rock salt layers locally containing potassium salts alternate

with anhydrites, dolomites and limestones. Two of these dolomite layers, namely the one at the base of the 2nd cycle (the "Main Dolomite") and the one near the base of the 3rd cycle (the "Platy Dolomite") constitute our gas carrier beds from which in 1958 some 11,000,000 cubic feet of dry gas per day could be produced and delivered to the State Gas Service for domestic use in six of the eleven provinces into which the country is divided. In the central, western and southern parts of the country evaporites have been found but no cyclic repetition thereof and the relatively thin Zechstein (400 feet, as opposed to a maximum thickness of 5,000 feet in the east) does not contain any gas. Besides anhydrite and dolomite, it contains some clastic rocks.

c. Lowermost Triassic (Bunter). Towards the end of the Permian the inland basin was gradually filled up, the sea receding northwards. The lower Triassic was deposited and started off with a variant of the Bunter, which here again is mainly of terrestrial origin. Near the top of the Bunter a rock salt layer is occasionally found. In places it attains a thickness of up to 280 feet. It can then be exploited to advantage as is done by the Royal Dutch Salt Industry near Hengelo in the eastern Netherlands. The salt is mined by a leaching process for which many boreholes were drilled. (cf. Section I).

d. Formation of basins in late Triassic, Jurassic and early Cretaceous times. After Bunter times (Lowermost Triassic) three ingresses of the sea occurred, the first in the middle Triassic or Muschelkalk period and the next in Upper Rhaetic or Lower Liassic, which continued during the Dogger. The latter covered a far wider area: almost the entire Netherlands was invaded.

The third occurred in the eastern Netherlands at the time of the deposition of the well known and productive Valanginian sandstone (which under the name of Bentheimer sandstone has provided the building material for many churches in the Netherlands: the outcrop occurs a short distance over our frontiers in the medieval German town of Bentheim, and it was here that, for the first time in this part of Europe, a gas bearing structure was proved productive).

In the west the third ingress arrived slightly later (during the Hauterivian) so that now two individual Cretaceous basins, separated in time and space, have been formed. Both determine the oil prospects of the country.

In the intervening periods, namely the Keuper between the first and second ingresses, Malm and Valanginian between the second and third, terrestrial to brackish water conditions prevailed, except in the east for a small period between Malm and Valanginian. The eastern Netherlands then started their own individual geological development when just before Wealden times a short invasion of the sea occurred. Proofs of this ingress are still found in the deposition of thin salt and anhydrite beds in Purbeck times (Upper Malm) offering, however, very little prospects of oil.

Also the marine Jurassic (Dogger) contributes but sparsely to Dutch oil production, only a few productive wells having been obtained so far, notably in the structures of Werkendam, Andel and Moerkapelle in the west: very different therefore from conditions in Germany where more and better Dogger production could be obtained.

III. *The Lower Cretaceous and its productivity*

a. Productive horizons (cf. Section II). The Lower Cretaceous is, then, laid down in two separate basins, which were gradually invaded by the sea. The main productive horizons lie stratigraphically in five different horizons. Their relative contribution to domestic oil production is set out below:

1. Basal so-called "transition" zone (continental to paralic facies)	0.2%
2. Valanginian (paralic to brackish facies)	67.3%
3. Valanginian Hauterivian (brackish to marine)	15.4%
4. Barremian (marine)	16.9%
5. Albian (marine)	only gas

The total thickness of the Lower Cretaceous varies considerably. Where the column is complete and comprises a complete Albian, it may attain a maximum thickness of approximately 3,000 feet in the east and about 5,000 feet in the west of the Netherlands.

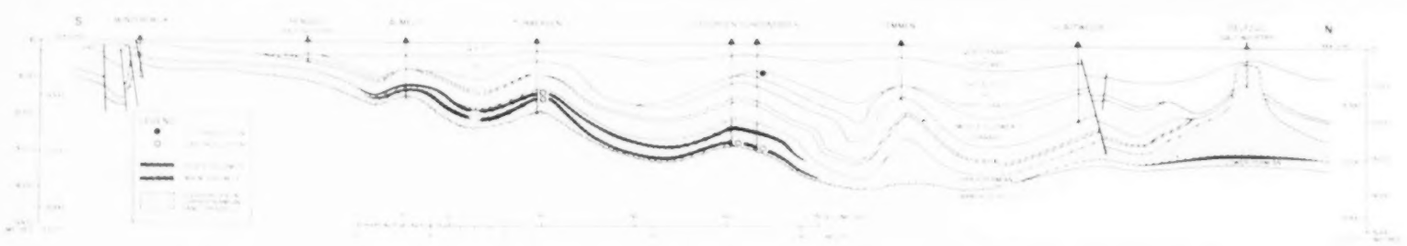
b. The oil sands. Productive sand thickness in the Cretaceous measures from approximately 200 feet to as little as 10 feet. Porosity varies relatively little between 20 and 30%, but permeability is extremely variable and may attain figures as high as 10 thousand milli d'Arcy in Valanginian or sink as low as 40 milli d'Arcy in Albian productive gas sands. The permeability of average productive oil sands in the middle of the Lower Cretaceous column averages 4,000 milli d'Arcy and water drive is a most common phenomenon.

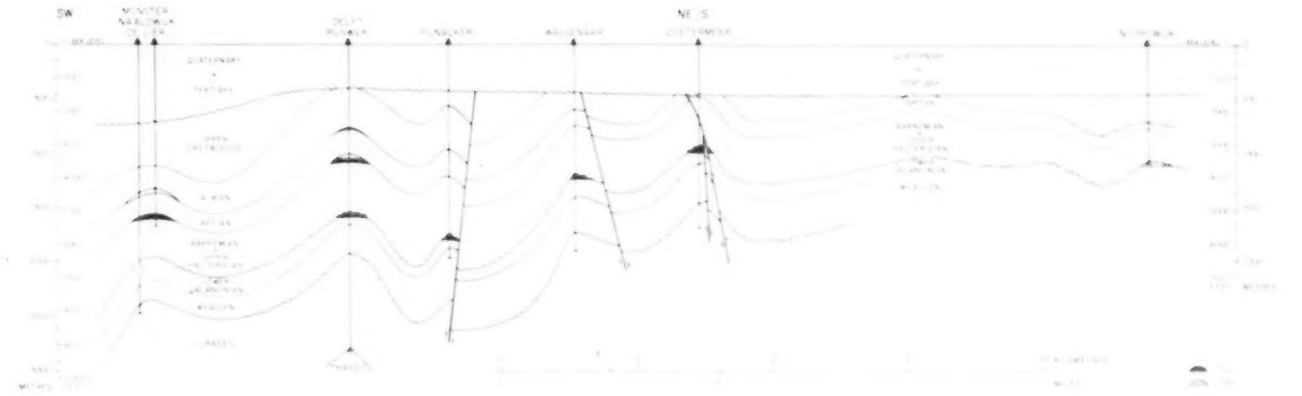
c. Types of crude and well productivity. It should be pointed out that paraffinic crude constitutes the bulk of present Dutch production, mainly because of the fact that the Schoonebeek crude (60%) is highly paraffinic. Also in the western Netherlands paraffinic crudes occur next to asphaltic crude in all horizons, but geographically paraffinic crudes are restricted to structures lying in the deeper part of the basin. The lightest crude has been found in the youngest formation, the Albian from which small samples of a 37° API crude with a pour point of +3° C have been extracted.

At Schoonebeek in the eastern Netherlands the crude still contains 6-7% paraffin near the edge of the German-Dutch basin and migration seems not to have altered its chemical nature except that the crude undoubtedly is weathered with a resulting gravity of 25° API. In the western Netherlands, however, crudes tend to become asphaltic near the edge of the basin in all horizons, apart from progressive loss of light constituents. The heaviest asphaltic crude being economically produced has so far been found at Moerkapelle in the northeast of the western basin, where an asphaltic crude of 14° API is being pumped with the assistance of bottom hole electric heating.

Indeed two different families of crude are being produced in the west, one with pour points between +5 and +25° C and API gravities ranging between 36.5° and 27.5° and the other with pour points between −17 and −5° C and gravities varying between 19.5 and 14° API. Both, however, occur in

Section I





Section II

the same horizons, though at different distances from the axis of the basin. This peculiarity prevents N. A. M. from constructing one collecting net of pipelines. On the other hand, it causes considerable differences in the productivity of wells in the various fields, which depends not only on permeability but also on the type of the crude and the depth of the productive level, as these again greatly influence underground viscosity. On the whole, however, productivity is reasonable, the average well production being at present approximately 100 b/d per well.

d. Migration. It is clear from the above that horizontal migration has affected the chemical composition of the crude. The migration path has been influenced not only by folding, but undoubtedly also to a great extent by faulting apart from tilting in later phases.

Folding went hand in hand with faulting in the Laramic phase. Folding is gentle except near the faults amongst which we find upthrusts almost as often as normal faults. The vertical throw of faults may attain up to 1,200 feet in the case of upthrusts, whilst 400 feet is a good size normal fault. Generally, however, the vertical movements are less and restricted to magnitudes of 100 to 200 feet. Undoubtedly some faults are revived disturbances of early origin and fault movements simultaneous with deposition are not uncommon. The resulting size of the structures is definitely not large, measured by international standards. The longest productive structure in the Netherlands is still Schoonebeek, which measures approximately 10 miles along its axis. In the west a five-mile structure is a good one and many are smaller. The size of reserves is still questionable, as our western fields mostly happen to lie near towns which are a great impediment to rapid appraisal. Consequently most of these fields are still only partially drilled, whilst other reserves of highly viscous crudes may only show reasonable yields after the application of secondary recovery methods. However, it may be safely predicted that the present rate of production of between 30 and 35 thousand barrels per day may be maintained on the basis of the present finds for a number of years, which, considering that the Netherlands has produced almost 75 million barrels of crude from the Cretaceous formation is no unsatisfactory exploration result.

IV. *Overburden of the Lower Cretaceous.*

a. Upper Cretaceous. It will not be out of place to conclude this survey with a few words about the nonproductive Upper Cretaceous formations (Cenomanian, Turonian, Senonian) which occur as definitely marine formations overlying the folded and faulted Lower Cretaceous. The Cenomanian sea covered not only our Lower Cretaceous basins but also vast areas beyond them and the Senonian was deposited even farther inland. The Upper Cretaceous period closed with the Laramic uplift and folding, which caused a regression of the sea and erosion in the major part of the country, by which variable amounts of older sediments have been removed.

b. Tertiary. On it the Tertiary was deposited whilst the country was partly sinking again. On the whole the movement was of an oscillating nature. In Brabant old faults revived and a trough came into being. In general the older Tertiary covers less territory than the younger part which progressively overlaps older formations.

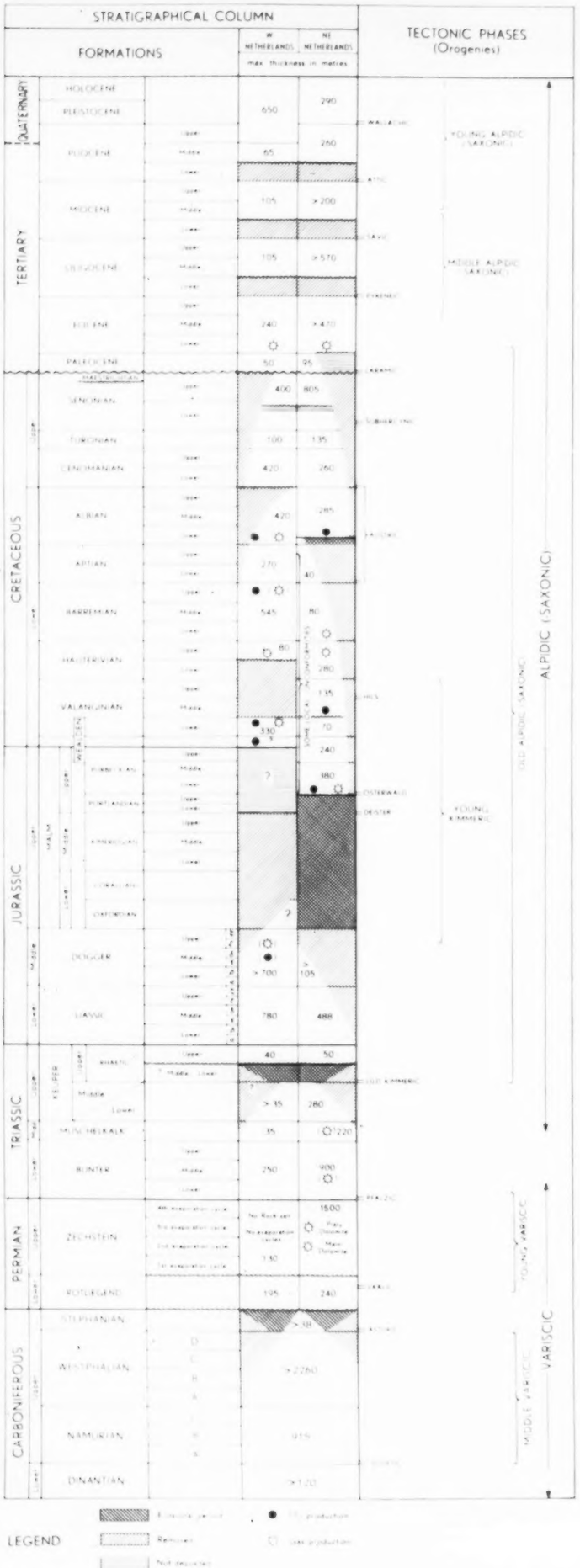
It is the basis of the Tertiary which is picked up easily by seismic reflection methods, giving, however, little real clue to deeper structural conditions. It was therefore essential to a successful search for oil that deeper yet reliable reflections could be picked up. Progress has been made especially during latter years—which explains the relatively high number of discoveries from 1955 to 1957. On the other hand, the swampy state of the western Netherlands and the intensive weathering of the top soil still cause many difficulties.

c. Quaternary. A discussion of Quaternary can be omitted. Although the fact that it sometimes appears to be affected by sustained or revived faulting is remarkable, no Quaternary seepages are known. Gas emanation is still universally believed as originating in peat layers.

B. Geophysical exploration.

The search of the country by geophysical means and methods started off in 1935 with gravity surveys, conducted by Bataafsche (B.P.M., one of the two main operating companies of the Royal Dutch Shell Group). In the beginning the Holweck pendulum was used, but was soon superseded by the Thyssen-Graf apparatus which in turn made way for the North American gravity meter. A total of 18,000 locations were measured before the end of World War II. After World War II the Nederlandse Aardolie Maatschappij (Netherlands Petroleum Company) measured another 8,000 stations to round off this gravity work in 1950. Only a few thousand stations have since been measured, some of which were actually located in the streets of the city of The Hague and the remainder covers the eastern half of the continental shelf lying off the Dutch coast. Since 1956 no further gravity work has been carried out. Core hole drilling before World War II followed by refraction shooting revealed the location of the Schoonebeek anticline. After World War II seismic reflection work was vigorously started after N. A. M. had been formed in 1947. Since that year a primary, relatively wide grid has been shot all over the country, followed up by detailed work spreading out from the earlier discoveries in the east and the Rijswijk discovery of 1953 in the west. Up to the end of 1958 a total of 78,247 shot holes were drilled, requiring the drilling of 3,324,660 feet of hole and resulting in about 7,000 miles of continuous seismic sections. Various instruments have been in use, whilst improved methods were gradually evolved. In 1955 bunching of

THE NETHERLANDS



seismometers in combination with pattern shooting was introduced. The great number of shot holes required could only be drilled after rotational drilling had given way to the flushing of shot holes with the aid of mud pumps. Finally, in 1956 variable area recording came into full use, considerably speeding up interpretation. Since 1955 two parties have been working regularly, one of which is supplied by the German geophysical contractor Prakla from Hanover. Seismic surveys in the Netherlands have to cope with many difficulties, apart from those caused by the nature of the soil and the intensive cultivation, as especially in the west, canals and rivers, dikes and towns impede work. Progress averages approximately 25 miles per party per month.

C. Mining Act and Concessions.

As early as 1932 the Government was approached by representatives of the oil industry with the information that the presence of bitumen within Dutch territory was not unlikely. B.P.M., one of the two main operating companies of the Royal Dutch/Shell declared itself prepared to start exploration for oil and gas. In view of the risk run the Government passed an Act in 1933, allowing B.P.M. an exclusive search for oil and gas with the means of bore holes thus temporarily curtailing the freedom of exploration as guaranteed by the Mining Act which, dating from 1810, still existed in the form originally given by Napoleon.

Although during this initial period Schoonebeek anticline had already been picked up before World War II, and the first Cretaceous oil was struck in 1944, no shipment of oil was made until after the liberation. From this moment development of the field was actively taken in hand, whilst exploration, by seismic or by drilling, was spread over the entire country. Whereas between 1935 and 1947 the drilling of exploration wells was limited to about 60 relatively shallow reconnaissance wells, afterwards a great number of wildcats with depths ranging between 7,000 and 12,000 feet were struck all over the country with the aid of modern tools which came into use in 1948. This resumption of active search for oil and gas coincided with the formation of the Nederlandse Aardolie Maatschappij (Netherlands Petroleum Company) in which the Royal Dutch/Shell and the Standard Oil New Jersey each took a 50% interest. Concessions were applied for as soon as economic production was proved, in conformity with the Mining Act. The Crown granted three such concessions (some of them in stages). Two of these are situated in the east and one covers part of the Province of Holland in the west. All three together have a surface area of more than 1,000 square miles.

D. Drilling and Development.

1. *Historical review.*

Until World War II drilling was confined to the eastern part of the country and carried out with a heavy Conrad counterflush outfit capable of drilling to approximately 3,000 feet. Also during the war and for a short time after, B.P.M. continued drilling with whatever type of installation could be made available. A total of 11 holes were drilled before World War II, followed by some 50 reconnaissance wells until the end of 1947, apart from some 25 appraisal wells in the Schoonebeek field.

As from 1947 some 124 exploration and 409

exploitation wells were drilled with modern tools, using Ideco H 25 and H 30 installations for shallow wells and Ideal 50 or Ideal 100 rigs for medium depth and deeper wells, in combination with one Ideal 55 rig operated since 1956 by the International Drilling Co., a drilling contractor recently incorporated in the Netherlands. The Netherlands Drilling Co., a subsidiary of Drillexco, and also incorporated in Holland, has also contracted for drilling work from 1953 onwards.

2. *Drilling speed and methods.*

From 1947 to 1953 the number of active drilling rigs was increased from approximately three to eight, but after that reduced to four (one of which was operated by a contractor) in accordance with variations of prospects and increase in drilling speed. The latter is clearly demonstrated by the fact that the total footage drilled with eight strings in 1953 was exactly the same as the footage drilled with five strings in 1957 (260,000 ft). The relation between average progress and well depth and the offsetting effect of increased efficiency can be seen from the chart on page 9.

This table explains why N. A. M. could explore and simultaneously increase its production by no less than 40% in the year of the Suez crisis, using five strings only. Apart from extensive training of local labor and increasing the efficiency of drilling methods, progress in drilling speed was mainly due to increased weight on bit and the application of jet rock bits. Moving was speeded up by the introduction of an Ideco Full View mast by which the erection of the usual, fixed derricks could be obviated in many cases. The necessity, however, of drilling deviated wells from multiple locations when drilling in or near towns still makes a fixed derrick made by De Vries Robbé (Gorinchem, Holland) a common sight in the Netherlands. The depth to be drilled varies rather widely. The 347 wells drilled at Schoonebeek average somewhat less than 3,000 feet, productive wells in the western fields, ranging, however, from 3,000 to 6,500 feet; whilst productive gas wells in the eastern part of the country have a maximum depth of about 10,000 feet. The deepest exploration well reached a depth of 12,450 feet.

For these varied objectives N. A. M. has hitherto used the Diesel-powered Ideal 50 or 100 installations. Since it appeared that a considerable amount of production could be obtained between 3,000 and 4,000 feet and that exploration of the west seldom requires more than 8,000 feet of hole per well, the Ideco H 30 and Ideal 55 both with masts were brought into use. As the Ideal 50 and 100 rigs require replacement, specialization will be carried further by the introduction of a modern Ideco H 30 supplied from Italy and an electrically-powered direct current Ideal 55 rig, whilst the acquisition of an electrically powered alternating current installation with torque converter drives enabling the drilling of wells of more than 12,000 feet is contemplated. As a matter of fact, N. A. M. will use the design of a direct constant current drive which was developed between B. P. M. and the well-known Dutch firm of Smit, Slikkerveer and the electrically-driven AC installation with Siemens, Germany. These electrically driven rigs offer several advantages, certainly in a country where the size and shape of drilling locations often suffer many restrictions. Soundproofing of installations is a "must" in many instances, and therefore N. A. M. will give preference in future to shaft-driven outfits.

Drilling in Holland does not present any special problems, but in several areas formations are rather unstable, requiring a very good quality oil emulsion mud with a low water loss factor (1-3 cc A. P. I.). The wells drilled to the gas-bearing Dolomites of the Zechstein often penetrate thick beds of rocksalt; the greatest thickness encountered so far was about 4,459 feet at Ten Boer. As moreover reservoir pressures are generally above hydrostatic, saturated saltwater-clay-barytes muds with a specific gravity of up to 12.5 lb/gal are used in these cases.

In several wells tests were carried out with turbine drilling (Neyrpic Turbine). In the soft to medium-hard formations the turbine rockbit combination did not prove too successful, but in the harder, deeper formations of the Triassic and the Permian the use of the turbine combined with diamond bits (supplied by one or other of the three firms of Smit—Amsterdam, Bruyaux—Belgium, or Christensen—France) proved promising.

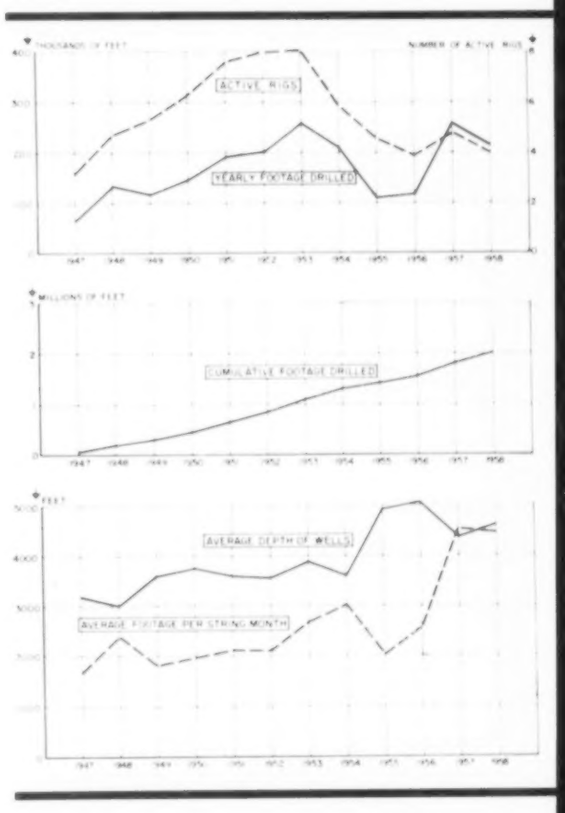
In the western part of Holland the majority of the oil fields are situated below built up or horticultural areas. Where necessary, available locations are therefore used to drill several directional wells. These are deviated with the aid of whipstocks and bottom hole orientating devices, used in conjunction with nonmagnetic monel drill collars. Generally the angle of deviation is built up to 20-30°, horizontal displacement amounting to 800-1,300 feet.

Recently "big-eye" bits were used to build up the angle of deviation in the soft top formations. Preliminary indications are quite promising, but this system has not yet been adopted as routine.

The Wassenaar field, being developed on a spacing of 800 feet, now has 16 wells, drilled from four sites. Also in the "greenhouse" area of De Lier and in the drinking water concession of The Hague in the dunes directional drilling has become routine, whilst in the IJsselmonde area the development of the oil field, necessitating many directionally drilled wells, is being worked out round the table with town planning authorities. To obtain sufficient horizontal displacement in the required direction in these very soft shallow formations still presents difficulties.

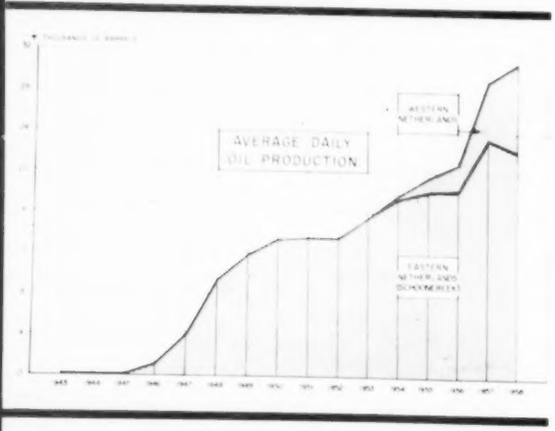
3. *Equipment and services.*

For the rapid development of the oil industry in Holland large quantities of materials and equipment are, of course, needed. In the years immediately following World War II these had to be imported, but gradually Dutch industry took over an important part of its supply. Of the total value expended on materials and equipment almost 40% is now spent in the country, on such varied items as pumping units, electric motors, separators, valves, pumps, derricks, blocklines, rockbits (made in licence by Reed), electrical equipment, oilwell cement, mud chemicals, dehydration chemicals etc. Tubulars such as casing, tubing and line pipe are purchased from various other countries, mainly from Germany and occasionally from Austria, Italy, France or Belgium. Sucker rods are, for instance, obtained from Austria, drill collars in Austria and Germany, drillpipe, however, being supplied from the U. S. A. Obviously, highly specialized material and equipment must be obtained from the United States. As still 60% of the materials consumed is purchased abroad, consid-



erable capital is tied up in stores, a typical feature of European oil producing companies. The amount of capital frozen in stores is of course reduced as much as possible but can hardly be cut down to below approximately six months' consumption. Similarly, many services cannot be obtained from specialized outsiders and must be carried out by the operating company itself. In this connection may be mentioned mud control, cementing (at present carried out with bulk cementers, the containers for which are supplied direct by local factories) as well as formation testing, in which field N. A. M. uses Johnston equipment; also measurements of bottom hole pressures are carried out by the operating company with Amerada and Maihak tools, the latter being supplied from Hamburg. Deviation measurements are carried out either by the operating company with Totco or Eastman instruments or else by Schlumberger, which maintains a base in the Netherlands which gives N. A. M. regular assistance in the field of logging, perforating or string shooting. Occasionally the Eastman agency in Germany has made gyroscopical deviation surveys in cased wells. Also operating from Germany, Halliburton frequently renders services when acidizing Dolomite wells with hydrochloric acid supplied by Royal Dutch Salt Factory, or when fracturing is needed of fine grained, ill sorted and therefore rather tight productive sands in either the Jurassic or the uppermost Lower Cretaceous beds. In Schoonebeek wells, where the casing is always cemented above the layer, the home made slotted liners are gravel-packed by Halliburton.

From the above it appears that although expert advice and specialized services are available, the Dutch oilman should be well versed in the handling of all tools and the application of many specialized operations. In this matter N. A. M. is lucky to be able to draw from the personnel resources of the Royal Dutch Shell and to receive advice and guidance from the research organizations of the two largest oil companies in the world. It is thanks to this that N. A. M. was able to build up in a very short period an up to date oil producing organization on the continent of Europe, although the foregoing also shows to what extent inter-European exchange of services and goods is realized in practice, to the great benefit of efficient specialization.



4. *Production level.*

Present production in the Netherlands attained its maximum in 1958 with 11,287,000 barrels over the year. As said before, approximately two thirds of this amount was produced by Schoonebeek and one third by 11 scattered producing-fields in the west, five of which are up till now just "one" to "three-well" fields. By the year end of 1958, however, the share of western Holland had already risen to 40% of the then developed daily production of 35,000 barrels, thereby compensating for the drop of the Schoonebeek field, where production gradually declined from its peak of 26,000 b d in 1957 to 21,000 at the end of 1958.

5. *Production methods.*

The bulk of the Schoonebeek production is produced by pumping, necessary because the reservoir pressure is slightly below the hydrostatic and therefore too low to lift the present volume of 95,000 barrels of salt formation water per day together with the oil, the more so as the gas fluid ratio is low (about 10 or 45 cu ft bbl). Due to the fact that water drive is intensive on the flanks but part of the western crestal area is producing under depletion conditions, the size of the wells varies considerably between say 10 and 650 b d of clean oil. To meet these varied conditions, four different types of pumping units are in use. The majority are made by Thomassen (De Steeg) and some by Le Grand (England). The biggest units have a ten-foot stroke with a capacity of 30,000 pounds polished rod load and are able to lift about 2,000 barrels of fluid per day. Pumps are of the tubing or insert type made by Thomassen and Burtonwood, whilst some are of the fluid-packed type. The size of the upset tubing used varies from $2^{3}/_{8}$" to $4^{1}/_{2}$" and is used in combination with the corresponding pump diameters. On an average about 1,400 well pulling jobs have to be made yearly because of rod breakages, pump repairs or cleanout of sand or paraffin wax over a total of some 275 producing wells for which Woodfield diesel-driven hoists with telescopic masts, supplied from Great Britain, are used. Relatively dry wells are dewaxed electrically with direct current of a voltage of 40-100 V and 400-1,000 amp.

Erosion of slotted liners occasionally occurs, necessitating lately the reworking of some 20 wells per year. For the past two years all new and reworked wells have been under-reamed and provided with a gravel pack with a grain size of $^{5}/_{64}$ inch. Liner slots are then about $^{3}/_{64}$ inch, whereas without gravel packs slots are $^{1}/_{64}$ inch. The oil sand is definitely coarser towards the top of the layer and becomes clayey and silty near the bottom. As Schoonebeek is not only an anticlinal trap but also a stratigraphic one, the productive sand thickness in the wells varies between about six feet in the western area (where the sand pinches out) to about 120 feet along the flanks and on the eastern plunge. Consequently sand troubles vary greatly, increasing with increased water cut.

The reservoir temperature is about 38° C, the oil reaching the surface at about 28° C, so that with a pour point of 9° C due to a paraffin wax content of 6-7% the oil needs heating up in nearby block stations.

The distance from the wells to the block stations is therefore never more than 2,000 feet, the flow lines being non-insulated and buried approximately three feet deep. In 18 of such block stations the gross fluid is collected, gas and free water separated automatically and the remaining emulsion heated to 45° C in order to be pumped to the central tank farm and adjoining loading station after injection of chemical dehydration agents. At the main tank farm dehydration is followed up by electrical desalting, after which the oil is carried by rail with a water content of 0.5% and a salt content of 20,000-35,000 ppm, in order to be processed in the refineries near Rotterdam which deliver the products to the sales companies of both parent groups.

Also in the western Netherlands the wells in some fields producing heavy crudes (Zoetermeer, Moerkapelle) have to be pumped, sometimes in conjunction with bottom hole electric heating, whilst the De Lier field producing under solution gas drive and suffering from drop of reservoir pressure possesses various pumping wells (depth of productive level 6,000 feet) besides an increasing number of gas lift wells.

All pumping is done electrically, the electricity being supplied by the city or provincial power plants. Intermittent pumping is applied wherever practicable.

Since high pressure dry gas was discovered at approximately 10,000 feet in Permian Dolomites at Schoonebeek itself, gas lift is being developed in this field also, 10% of the gross fluid already being lifted by this method. This will be extended as soon as the low pressure wet gas can be delivered to the State Gas Service, which is building a compressor station.

In the western Netherlands most of the oil production is still flowing and so far the majority of the fields seem to produce under strong and almost ideal water drive conditions. Only when the water cut becomes high, must gas lift come to the rescue, the gas

Deviated bore holes near Rijswijk, in the West of the country.

being introduced into the casing, and the tubing being equipped with either Otis, Merla or Camco valves. In the west the return gas from these wells is already being collected and delivered to the State Gas Service.

A fair number of pumping and gas lift wells are provided with Maihak (Germany) automatic pressure recorders, whilst moreover reservoir and flowing pressures are being regularly determined by travelling N. A. M. crews.

Before the introduction of gas lift, vertical hydraulic pumping units were tried out but not introduced as standard equipment. No underground hydraulic type or electrically driven turbine pumps are in use but a test is to be made with a vibrating membrane pump of German invention.

6. Disposal of salt water, cold flooding and desalting of crude.

The salt content of the formation water varies between 70 and 110 thousand ppm and all spilling of salt water is prohibited. In Schoonebeek this water is disposed of by pumping back into the layer, which receives it without any extra pressure. At the block stations part of the water is separated in free water knock outs and directly pumped over to the injection wells, whilst the water obtained at the dehydration plant needs intensive cleaning. This is carried out at a central water treating plant where the water is freed from oil, inorganic impurities and finally deaerated under vacuum. It is subsequently run back to the 18 injection wells which have been completed along the flanks at a distance of approximately $\frac{1}{4}$-$\frac{1}{2}$ mile from the original oil water contact. These wells only need one single clean out per year, effected by reversing the direction of flow, by swabbing or gas lift. Salt water disposal in Schoonebeek means cold flooding and pressure maintenance, the total quantity injected amounting to 110 million barrels, thus replacing as much as two thirds of the total fluid extracted in the whole field. Reservoir pressure seems to be constant at present. In western Holland formation water is separated at the block stations with the aid of chemicals and then run off in plastic lines to public sewers which debouch into the North Sea. This procedure is permissible as long as reservoir pressure there shows no decline. A separate desalting plant has been built at the terminal of the pipeline, connecting a number of the fields in this area. The crude of the remaining fields is being transported by barge either straight to the refinery or discharged at the desalting plant to be treated if necessary. Only from one field (Wassenaar) is the crude carried by rail after dehydration. This latter crude is used as a fuel component.

7. Use of plastics.

In the above the use of plastic lines for the disposal of salt water was mentioned. Plastics are also tried out in combating the deposition of paraffin wax in flow lines and tubing by using coatings of plastic. Even in pumping wells these coatings proved to be of great value. Plastic coating of rods is also under test.

8. Secondary recovery methods.

Undoubtedly cold flooding provides a means of increasing recovery, were it only for its beneficial effect on reservoir pressure. In terms of reservoir volume cold flooding has really only just started, as recirculating the total pore volume three to four times is envisaged. A further step to increase recovery is the injection of hot water into water drive areas, where the nature of the oil and especially its reservoir viscosity merits its application. Actually, at Schoonebeek a hot water injection test in a small region of the water drive area has been in progress since 1956. Salt formation water is being injected at a rate of a little over 3,000 b. d. at a temperature of 230° C. This rate is equal to the daily gross production of the area. The test region is bounded updip and laterally on one side by faults. The hot water is injected downflank, and in order to prevent this from escaping sideways, the test area is flanked by a shield region where quantities of cold water equal to the offtake of that region are injected. To check the advance of the hot water, tritium was added to the injection water for a short period and the radio activity and temperature of the water in the producing wells measured. As was anticipated, the effect of this hot water drive was not seen for a long time but is now becoming favorably apparent.

In a small fault block of the gas solution drive area a gas injection test was carried out in 1955/56. About 3 mmcf/d of gas was injected, but as the gas leaked across the faults into adjacent areas, results were inconclusive and the test was abandoned.

In the gas solution drive area two new secondary recovery schemes will start in the near future.

Firstly *in situ* combustion will be carried out on three adjacent 7-spots with a well spacing of about 600 feet. Two compressors are on order with a daily capacity of about 6.5 mmcf each at a delivery pressure of 1,000 psi. The producing and injection wells will be equipped with stainless steel liners while the productive wells also will be provided with the water cooling in the casing.

Secondly, a steam injection scheme will be started on four 5-spots with similar distances from injection to production wells. The four boilers will have a combined daily capacity of 960 tons of steam with a temperature of 200° C.

Preliminary work for both the above schemes will be carried out in 1959 and it is expected that they will be embarked upon during the first half of 1960.

The Schoonebeek field has been drilled on a primary well spacing of 1,300 feet. During the latter part of 1956 and early 1957 twenty interspaced wells were drilled and it is the intention gradually to continue interspacing the remainder of the water drive area, the more so as the results obtained not only ensure accelerated production but also make it very probable that recovery will be increased.

In the west where interspacing at a later stage, especially in and near towns, is quite out of the question, well spacing is held between 700 and 1,000 feet. In contrast to Schoonebeek many wells in the west simultaneously produce from different sands, and casings are cemented on bottom and perforated. Often stage collars are used when several productive horizons have to be isolated, requiring long cement-columns.

Secondary recovery methods can only be contemplated after the fields discovered have been drilled up. It may be regarded as highly probable that the heavy asphaltic crudes will need some sort of secondary recovery methods thereafter at an early stage.

9. Transportation of crude.

From the foregoing it is evident that at present all means of transportation of crudes are being used, including road transport by tank truck of production obtained from new discoveries. Furthermore, carriage by rail of Schoonebeek crude effects a saving as compared with transport by pipeline, the latter requiring many heating stations.

It has already been pointed out that in the

The Schoonebeek oil train.

west one system of connecting pipelines is impracticable, especially because the waxy crudes require high pumping speeds and relatively small line diameters, whereas the asphaltic crudes require large diameters because of high viscosities. Moreover, some of this latter type of crudes do not require any refinery treatment at all.

This explains why up to now only the fields of Pijnacker, Rijswijk and De Lier have been connected via the desalting plant with the refineries at Pernis-near-Rotterdam by means of a 3-6" insulated pipeline of some 20 miles. One intermediate heating station is used.

As to the other western crudes the ultimate method of transportation is still under study. It may be mentioned in conclusion that all pipelines have been provided with complete cathodic protection.

10. *Gas production.*

Apart from the matter of wet gas production discussed in the foregoing, the discovery of a number of dry gas fields in both east and west has been mentioned. In the east these have already been put into production. Most of these latter gas fields produce from Permian Dolomites, which, especially after acidizing, yield high potentials, the more so as formation pressures are mostly high (up to 4,400 psi). To this type of field belong Coevorden, which was the first to be discovered in 1948, Tubbergen, Denekamp, Rossum and De Lutte, as also Ten Boer in the north and finally Schoonebeek itself. Some other fields produce gas of undoubtedly Permian origin which migrated along the bottom of salt II into higher layers of various age. De Wijk, Staphorst and Wanneperveen are of this type.

Under the conditions of the exploitation concessions as prevailing since 1950 N. A. M. is committed to offer any gas not needed for its own operations to the Government—recently for which the State Gas Service has been substituted—which has hitherto asked for guaranteed mean daily quantities to be produced over a period of 20 years. The offer made about 1953 foresaw an aggregate delivery of 100,000 million cubic feet in 20 years. Recently in 1958 this offer was increased to 194,000 million cubic feet over the same period. Moreover, N. A. M. discovered dry gas reserves in excess of its needs in the Albian sandy formations of De Lier field in the west. The drilling of gas wells is now being carried out there, and 30,000 million cubic feet has been offered recently over the next 20 years to the same State body. This organization takes care of the piping, distribution and resale throughout the country. The needs of N. A. M. comprise the amounts of gas required for its operations, such as heating of crude or emulsions, gas lift and secondary recovery methods.

In gas wells penetrating Permian salt and anhydrite, special sulfate-resisting cements are used, whilst these wells have been provided with inner protective strings of casing which, set by a packer above the producing horizon, are filled in their annular space with an anti-corrosive mud. No special valves or chokes are used in such wells except when the diameter of the hole is so small that the lower end of the tubing itself has to be run through the packer, and the annular space behind the tubing is filled with fluid. In such wells Otis valves are in use.

11. *Sulfur content of crude or gas.*

All Dutch crudes are sweet, as is most of the gas derived from sandy formations. Only the gas produced from Dolomites contains variable but notable quantities of H_2S and mercaptans. The purification of this gas is the responsibility of the State Gas Service. Sweet crude is a premium crude and comes in handy in a country which is largely dependent on imported sulfur bearing crudes.

12. *Relations between home consumption and production.*

For the past ten years N. A. M. has supplied between 25 and 30% of the Dutch inland needs of petroleum products. It should be pointed out that it is merely accidental that the growth of N. A. M.'s production kept pace during these years with the increase of local consumption due to increased industrialization and traffic. Whereas consumption depends on the state of prosperity of the country and the growth of its population, oil production is primarily related to the size and geological build-up of its territory. A deviation between the graphs of consumption and production must therefore be expected at some moment in the future. Nevertheless it can be regarded as a satisfactory achievement that Dutch domestic oil production still comes forth in Western Europe whilst, calculated per unit of area, its production almost equals that of the United States and ranks first in Western Europe, thereby strengthening the financial position of the country. Undoubtedly stability in the fields of labor, law and finance has been an important contributory factor, as also the fact that the local producer could make full use of the experience gained all over the world and placed at its disposal by its parent companies. The result is one of which private enterprise may be righteously proud of.

Petroleum gas and the state gas service

All petroleum gas, of whatever origin, sold to outside concerns has been used up to now for public utilities. This is a typical Dutch feature which will be explained later.

To emphasize the growing importance of petroleum gas in the Netherlands a few figures may be cited. In 1950 no refinery or natural gas was consumed, whereas in 1957 already 21% of the total gas requirements of the country came from these two sources, as compared with 36% coke oven gas and 41% gas produced in local gas works.

Thus it is clear that the gas supply of the Netherlands has undergone a very great change in the past few years. Before World War II most of the domestic and industrial gas was made and supplied by the various municipalities from local gas works, numbering about 160. Deterioration and destruction during the war, coupled with the all-round need for almost complete replacement through superannuation, meant that in 1946 something very definite had to be done.

Total replacement of such a large number of installations was utterly impossible, not only because of the money involved but also because it was not then possible to obtain the equipment. Consequently a concentration of production had to take place, a development which was revolutionized in 1953 when the first sizeable supply of petroleum gas presented itself on the market, either from refineries or from gas fields.

By then, the southern provinces had already been supplied with coke oven gas from the State coal mines for some 20 years whilst the basic amount needed all the year round in the area of Amsterdam was being supplied by the Royal Netherlands Blast Furnaces. In other words, two long distance suppliers already existed, and under the circumstances it was only natural that the Government thought of long distance supply of refinery gas produced in the west or of natural gas from the east to provide the many municipalities in which the local gas works had to close down.

This idea was followed up by inserting a clause in the Concession Acts governing gas and oil concessions granted to the Netherlands Petroleum Company (N. A. M.) forbidding the local natural gas producer from offering any quantities for sale except to the Government; whilst almost simultaneously the State Gas Service was created, intended to be the owner of a public long distance grid of gas lines and the wholesale dealer of natural gas to municipal consumers, who act as retailers to the public.

As a result, many of the municipal works were able to close down their own producer plants, and a very extensive network of gas mains has been laid throughout the country. These are not yet fully interconnected, but plans are ready for this to be achieved in the near future. Nevertheless almost 59% of the total gas production for public supply takes already the form of long distance gas, two-fifths of which is supplied by the oil industry. It is anticipated, that by the end of 1959, 37% of the total gas needs of the Netherlands will be covered by the oil industry, and the same percentage by coke-oven gas, whilst conventional local production will cover only 26%.

The Netherlands Petroleum Company having recently intimated to the Government that supplies of natural gas could be doubled shortly, the oil industry will soon cover an even larger percentage of the country's needs.

As by now three important sources of long distance gas are available—refineries, natural gas fields and coke oven, all of them of very different quality—the need was felt for a national body which would ensure the most economic distribution and use in the country.

The National Gas Company thus came into existence recently, which will coordinate gas supplies and have the right to suppress local production if long distance gas is available in sufficient quantities at reasonable rates.

The State Gas Service is now buying and distributing not only all dry natural gas from the sole Dutch producing company, but also buying and compressing its so-called wet gas production, which is produced with the oil in the oil wells in the eastern and western parts of the country. Furthermore the State Gas Service takes care of the purification of the gas, in which connection two desulfurizing plants have been built in the east, one of which will start production of sodium sulfite in the near future. From the middle of 1959 two powerful compressor plants will be commissioned to inject the low pressure wet gas into the high pressure long distance grid, which is operated under a pressure of 570 psi.

The length of the network of the State Gas Service at the end of 1958 was 1,116 miles*, the gas being carried through seamless pipes of diameters ranging from 4 to 12 inches. The pipes are all electrically welded and have anti-corrosion cathodic protection. The Service sells and delivers the gas to 53 municipal gas companies, ten of the largest of these redistributing the natural gas after thermal or catalytic cracking. These companies serve 70 local distributing centers.

As for refineries, that of the Royal Dutch Shell has been delivering its excess refinery gas since 1953 to a corporation of a number of cities in the west, including Rotterdam and The Hague. By special arrangement, refinery gas is added to blue-water gas and low grade coal gas, or cracked in vertical coal gas ovens or in water gas plants. The Caltex Refinery has also offered to supply its excess gas to the State Gas Service, which will pipe it to a central cracking and distributing plant near Utrecht which is also connected with the national gas grid. Thus gas from different sources and of different calorific value will be transformed into a uniform gas thereby making it possible to change the supply pattern in the various seasons.

Finally, it may be pointed out that the State Gas Service already provides six of the 11 provinces with natural gas through its ever-expending grid of pipelines, on the extension of which it is spending more than the equivalent of $5 million a year.

* Note: the figure given in "Gas in Europe" (Report of the O.E.E.C., published in August 1958) is a misprint.

Pipelines for natural gas in the Netherlands. (Situation on January 1st 1959). By courtesy of: State gas service.

Manufacturing

Expansion is the keynote of the Dutch refineries

One of the most surprising changes of the past decade in Europe is the development of the Netherlands from a dominantly agricultural economy to a powerful industrial economy. And one of the most spectacular developments of this industrialization has undoubtedly been the growth of the petroleum refining center at Pernis, near Rotterdam, only 12 miles from the North Sea.

Concentrated entirely within an area of about 3,000 acres around the Petroleum Harbors of Rotterdam, there has gradually arisen a refinery complex with a capacity of around 360,000 barrels b/d, which by 1960 will have increased to more than 450,000 barrels. In 1958 the total refinery throughout was 112 million barrels.

The two crude oil refineries at present in operation are those of the Royal Dutch Shell with a capacity of 300,000 b d daily and Caltex with a capacity of 60,000 b d. They are both very well equipped for all the latest distilling, cracking and other manufacturing processes, whilst the Royal Dutch Shell refinery is supplemented in the same complex by modern plants for the manufacture of petrochemicals of many kinds.

Both refineries are most conveniently situated for large tankers up to 47,000 dwt which can berth right at the refinery sites, for in addition to the 11 million barrels of indigenous oil which arrives mainly by train, very large quantities of crude oil are brought in by tanker from the Middle East and Venezuela.

A third refinery is at present under construction at Rotterdam's Third Petroleum Harbor by Esso Nederland N. V., the Dutch affiliate of the Standard Oil Company New Jersey. This refinery, which will come on stream in 1960, will have an initial capacity of 95,000 b d, and here too tankers of up to 47,000 dwt will be able to berth right alongside the refinery.

When in 1961 larger tankers of up to 65,000 dwt will be accommodated in the new Europort under construction by the Rotterdam Harbor authorities, with an entrance—for the time being—almost right at the mouth of the river, crude oil will be pumped through pipelines not only to the refineries but also go over the Rhine-Ruhr trunkline to Western Germany. And by 1964 it is hoped that there may be 100,000 ton tankers arriving at Europort which then will be directly accessible from the sea, to feed the Pernis and other refineries.

The Royal Dutch/Shell Refinery

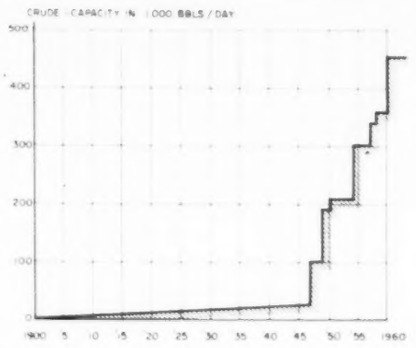
Started in 1902 as a small plant for the improvement of the quality of gasoline, the Royal Dutch Shell refinery at Pernis is now the largest in Europe. Even from the outset it started to grow, as by 1939 its capacity had been gradually increased to about 20,000 b d.

The end of World War II, however, necessitated the opening of a new chapter in the history of the plant, for the installations had been so damaged and stripped that almost complete reconstruction was necessary. The speed with which this was carried out can be seen from the fact that by 1946 the prewar output was already being exceeded, since then the refinery has made really remarkable growth to its present intake capacity of 300,000 b d.

The refinery is completely integrated. Its distilling capacity is presented by four crude units, two of which each have a capacity of 90,000 b d. By means of propane deasphalting, furfural extraction and M.E.K. dewaxing a full range of lubricants is now being manufactured. The slack wax is thermally cracked, and the resultant distillate, which is rich in unsaturated hydrocarbons, serves as a base material for the manufacture of detergents.

Apart from the conventional thermal cracking and reforming units, there are two catalytic cracking units of the "fluid bed" type, the capacity of which is over 65,000 b d. The hot CO gas resulting from the operation is burned in two large steam boilers and thus contributes in an efficient and useful way to the steam requirements of the refinery.

After the erection of an extraction plant for the manufacturing of high grade kerosine a catalytic reformer and two hydrodesulfurization units, working on the trickle stream principle, came on stream, in combination with a Claus plant for the production of sulfur.



Refining capacity in the Netherlands.

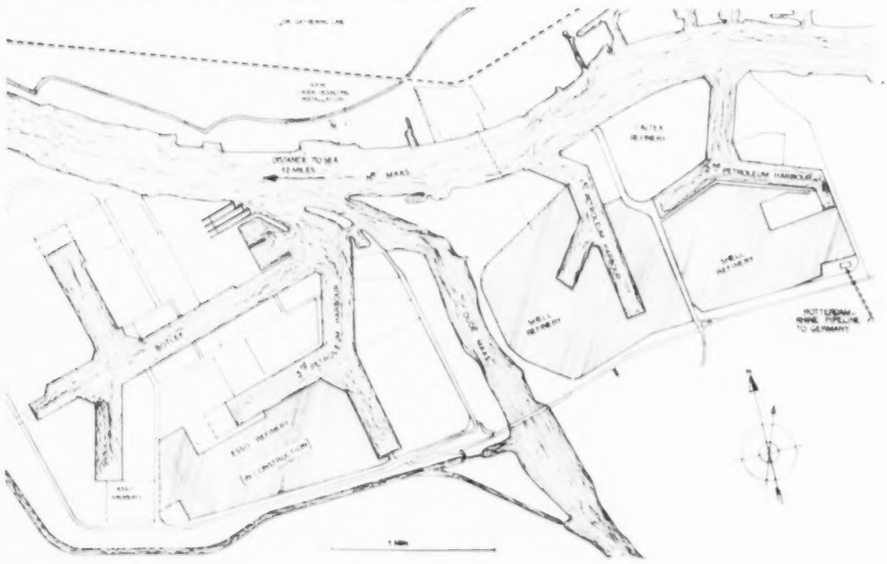
As an indication of the continued progress of this refinery the same year also saw the commissioning of a calcining plant for petroleum coke, a product of the thermal cracking units and an HF alkylation unit for the manufacturing of aviation gasoline.

Relatively large quantities of gas are supplied from this refinery to the gas distribution grid (described at some length in a special article) which in this particular case is operated by a provincial corporation of municipal gasworks.

The Caltex Refinery

This installation, also in Pernis, came on

Impression of the 3,000 acre Petroleum Harbors of Rotterdam.



Night view of Shell "Pernis" Refinery

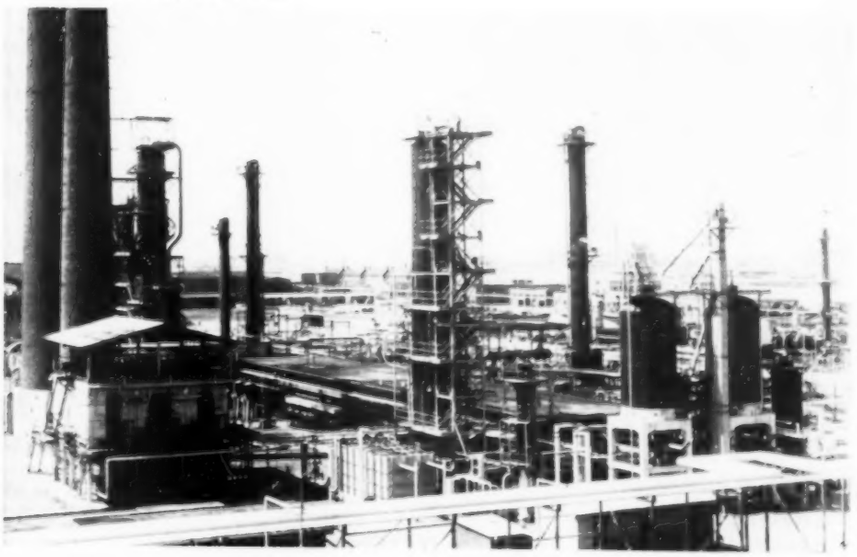
stream in 1950 with a throughput of 20,000 b/d. It then consisted of a two-stage atmospheric-vacuum crude distillation plant, thermal cracking and reforming units, a polymerization plant, a sulfur dioxide extraction plant for treating kerosine distillate, and various other treating units.

In harmony, however, with the need for a quality-improvement program, a Platformer with naphta Unifiner and a gas oil hydrodesulfurization unit were added in 1957.

Facilities were also built for the treatment of gas to be delivered to the Government for the national gas grid, and a Claus plant was erected for the production of sulfur.

The crude unit was recently revamped to accommodate the present increased throughput of 60,000 barrels b/d.

Caltex Thermal Cracker and Reformer



Construction of the Esso refinery makes steady progress.

The Esso Refinery

This new installation being built on a large site in the Botlek Harbor (a downstream extension of the main Rotterdam port complex) will have an initial capacity of 95,000 b/d and will come on stream in the first half of 1960. It will also have a Powerformer and a hydrodesulfurization unit.

A feature of special interest is that instead of the conventional water-cooling, "air-fin" coolers will be used, while floating roof tanks will be extensively employed for the storage of low flash stocks.

Petrochemicals Forge Ahead

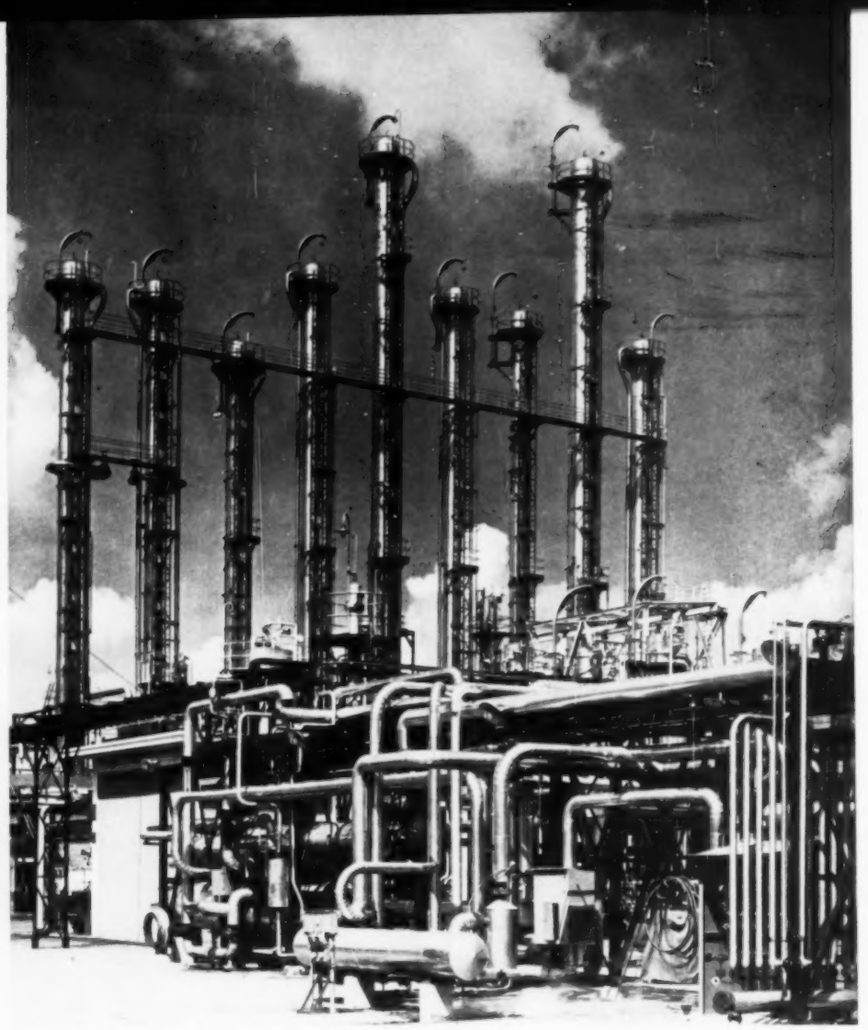
One of the many new industrial activities developed since the end of World War II has been the petrochemical industry. And such a rapid progress has been made that Holland is now one of the leading European countries in this field.

A graphic picture of the overall development of this industry and production can be seen from the accompanying diagram, which shows the total output of chemicals derived from petroleum in the Netherlands in the period 1948 to 1957.

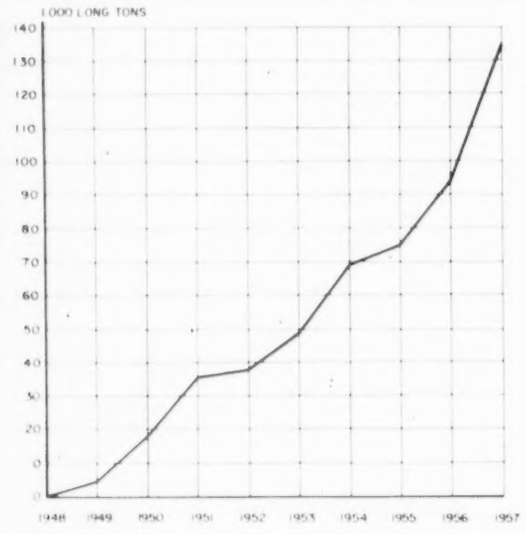
A particularly useful feature of this activity, moreover, is the fact that between 70% and 80% of the total production goes to foreign markets, which definitely eases foreign exchange problems.

Because this is a comparatively new industry in Holland, and necessitates very special and complex plant, there are only a few petrochemical installations in the country. For the present the Shell Pernis Chemical Plant is the main factor in the production of petrochemicals in Holland.

Adjacent to the Shell refinery at Pernis, the first section came on stream in 1947 for the production of sulfur from hydrogen sulfide obtained from the cracking processes.



Solvents plant Shell "Pernis" Chemical Industry



Petrochemicals production in the Netherlands.

Two years later a synthetic detergents plant and a polyvinyl chloride plant were brought into operation, and in 1952 a plant for the manufacture of "synthetic" resins was commissioned.

One of the advances in the development of this petrochemical industry, however, was the erection of the solvents plant which started production in 1954. Plants for insecticides followed in the next few years, whilst in 1956 a plant for the manufacture of allyl chloride and epichlorhydrin was installed as the first stage in the development of a series of projects based on the use of the substitutive chlorination of propylene.

The industry at Pernis continues to expand, and one of the most recent stages in the development was reached in 1958 when a plant for the manufacture of synthetic glycerine started operation.

Nor is that by any means the end. A plant for the manufacture of butadiene, styrene and synthetic rubber is now under construction and will come into production in 1960.

The Caltex refinery has also just entered this field of industry, having started making sulfur from refinery gases in 1958.

A "Safe" Record

Although oil refining on a large scale has a very short history in the Netherlands, the operators of the two refineries have managed to set up first class safety records. Every possible precaution is taken to prevent accidents or other troubles to the staff inside the installations, and the National Council's Safety Award of Merit for 1955 was given to the Caltex refinery.

The battle against pollution

Abatement of air and water pollution is actively pursued by the refineries concerned. The effects are watched in the Netherlands by Technical working groups of the Netherlands Government and the Rotterdam Municipality in close co-operation with the refinery authorities. That these efforts have been most successful is shown by the fact that only a small number of complaints has been received. Moreover this number has been decreasing during the past seven years, even though during that period the oil throughput has been doubled.

This freedom from risk to health, inconvenience and even annoyance, is an indispensable achievement when one has realized that the refineries are located in the immediate vicinity of one of the most densely populated areas of Europe.

The role of the refineries near Rotterdam-Western Europe

Although the population of the Netherlands (just over 11,000,000) is only 4% of the total of all the O. E. E. C. countries, about 14% of the total inland oil consumption of these countries is refined at Pernis. Export of oil products (excluding bunker fuel) to those countries in 1957 amounted to 60 million barrels, and in the same year shipping in Dutch ports was supplied with over 14 million barrels of bunker fuel, representing 18% of all bunker fuel supplied by the O. E. E. C. countries.

Dutch tanker fleet continues to grow

Oil companies play leading role

Traditionally men of the sea, even from the time when the Romans used a port of the Netherlands as the base for their forays towards Britain, the seafaring people of Holland have steadily developed into world carriers and traders, even to the extent of adventuring into unknown seas to explore for new markets and new products.

Despite its comparatively small size, the Netherlands stands seventh on the list of the world's mercantile marine, with a total of over 4½ million tons of ocean-going shipping. Of this total, about 27% is made up of tankers, making the Dutch fleet number eight on the international tanker list.

At the end of 1958 the tanker tonnage under the Dutch flag (vessels over 2,000 dwt) comprised 122 vessels of 1,769,000 dwt. Of these 90 vessels totalling 1,184,000 tons were owned by oil companies: 64 by Shell (853,000 dwt), 11 by Caltex (196,000 dwt), 4 by Esso (76,670 dwt), and 11 by other oil companies. The remaining 32 tankers were owned by independent shipping companies.

The tanker fleet of the oil companies included six supertankers each of 26,000 tons or more, of which two were owned by Shell, three by Caltex and one by Esso.

Regarding the future, we may mention that at the beginning of 1959 the Dutch oil companies had 20 new tankers under construction or on order, of which Shell had 11 (totalling 343,000 dwt), including seven supertankers, Caltex had four (totalling 154,000 dwt), all supertankers, as had Esso three (totalling 144,000 dwt) and other oil companies two (totalling 90,000 dwt). This makes a total of 731,000 dwt to be added to the oil companies' tanker fleets in the future, including not less than 16 supertankers which will account for 90% of this total new addition.

As independent shipping companies will be adding seven more tankers, totalling 175,000 dwt (including two supertankers) the grand total of augmentation of the Dutch tanker fleet by new construction will consist of 27 vessels representing about 900,000 tons, three quarters of which will be incorporated in 18 supertankers.

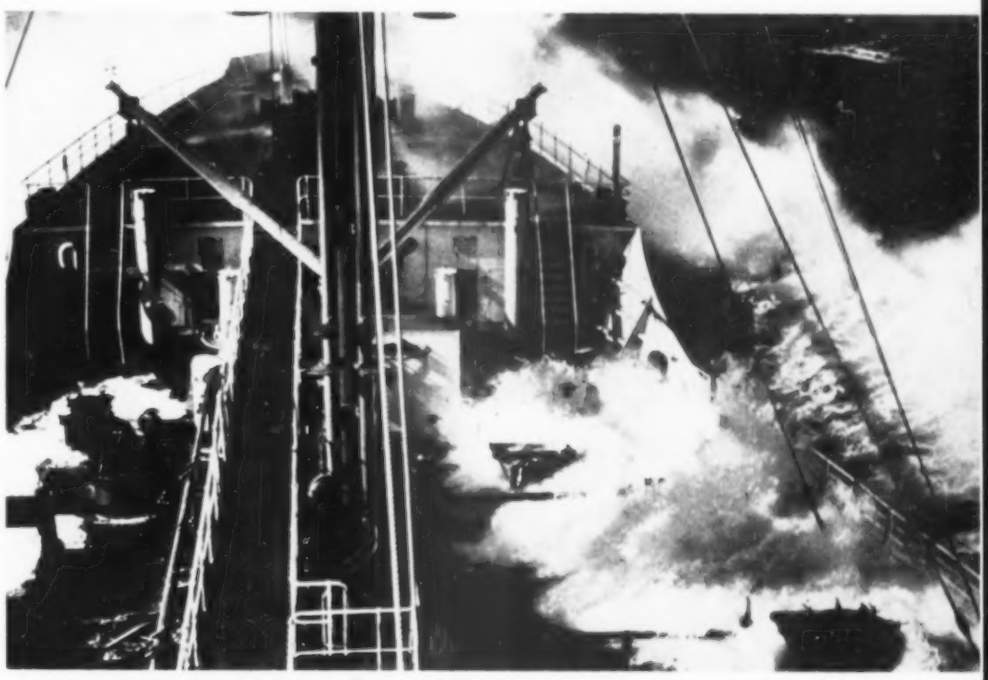
These figures show that oil company tonnage on a deadweight basis represents about two thirds of the existing Dutch tanker fleet and that four fifths of the increase to be added shortly will be provided from the same source.

The foregoing suffices to show that the oil companies in Holland are playing an increasingly prominent part in the tanker trade notwithstanding the fact that in the Netherlands they are relatively newcomers, and that their role compares favorably with the general situation in the world at large, in which 40% of the tanker tonnage is owned by oil companies.

where in this comprehensive review of Holland's part in oil activities, this is proving insufficient to carry the growing oil traffic, necessitating a new pipeline into Germany.

The remarkable part being played by Rotterdam in this rapid growth in the tanker trade will be depicted in a special article, but it can be emphasized here that the Dutch tanker fleet is more than contributing its share to this urgent need for port expansion.

Rotterdam already has three separate "petroleum harbors" catering exclusively to the oil traffic, and necessitated in no small measure by the expansion of refining. When the new Esso refinery is completed shortly, the combined capacity along with the Shell and Caltex refineries will be nearly 25 million tons a year. Almost all of this must of course be transported by tankers whilst crude shipments will certainly be increased again when the fourth petroleum harbor planned for the new Europort and now being built right on the North Sea, will come into use. When completed, this harbor will have an open entrance to the sea and may then be able to handle fully loaded 100,000-ton tankers; this development must be seen against the background of the increasing transport of oil by the crowded mighty river Rhine supplemented by pipeline which play their parts in catering for the growing fuel needs of industrial Western Europe.



Angry spray — A Shell tanker hits a patch of bad weather.

An Esso tanker being launched.

Holland's first trunkline

Relieving Congestion on the Rhine

Although pipelines for the transportation of oil were introduced into the United States by a Dutch immigrant, such pipelines are practically unknown in Holland. The reason why this part of the world lacks an intensive system of oil lines must be attributed to the fact that Europe has excellent waterways. But with the great river Rhine becoming congested and promising to become even more so with the increasing industrialization of Western Europe the transport of oil from the harbors along the shore inland—independent of weather conditions—has become a most important problem.

The present position of Rotterdam, the most important harbor in Western Europe, and as a matter of fact the second in the world, is best illustrated by its turnover of some 74 million tons of freight per year. Of this amount of freight shipped to and from the Rotterdam docks in 1957, about 30 million were connected with oil.

To cope with the prospects for the immediate future, therefore, the Rhine Pipeland Company (N. V. Rotterdam-Rijn Pijpleiding Mij.) was established in 1958 to lay and operate a pipeline carrying crude oil 180 miles from Rotterdam to the Rhine-Ruhr area, Western Germany's main industrial area, where it will be processed in refineries for local consumption.

Pipeline from Rotterdam to German Rhineland under construction.

A 24-inch line will run 96 miles from Rotterdam (Pernis) to Venlo near the Dutch border. One section of 56 miles will run to Godorf near Cologne, where a Deutsche Shell refinery is being built, and then on four miles to Wesseling to the Caltex-Tankkraft, whilst the other branch will go 25 miles to Wesel to connect with an existing pipeline to the Gelsenberg Benzin refinery.

The work, which was started last year with the help of American consultants—Bechtel International Company—will be completed by the middle of 1960. The pipe will be buried throughout its length at a depth of at least two feet, and will consist of welded sections 25 and 37 feet long. On its way to Germany it will have to cross many dikes, roads and rivers, and the most difficult of these crossings, namely the one under the Hollands Diep, over a mile wide, has been fully completed. This culvert is the biggest in Europe for a pipeline of these dimensions.

The pipe is covered with anti-corrosion layers and will also have cathodic protection.

Initially about 130,000 b/d of crude will be pumped from Rotterdam to the expanding Rhine-Ruhr marketing and industrial area. It is estimated that the maximum economic throughput will be around 400,000 b/d.

Shares in the N. V. Rotterdam-Rijn Pijpleiding Maatschappij are held by N. V. De Bataafsche Petroleum Maatschappij, The Hague (40%), (as mentioned before, one of the two main operating companies of the Royal Dutch Shell Group), by Gelsenberg & Mobile Oil Handels und Transport Gesellschaft, Hamburg (40%) and California Texas Oil Corporation (Caltex), New York (20%).

The total cost of the project will be equivalent of about $35.5 million.

Research

Progressive Plans and Activities

One of the secrets of the success of the Netherlands' industrialization in recent years has been that in this country great and careful attention has been paid to research, carried out not only by the universities and semi-official organizations but also by many of the large industrial enterprises. In this respect the oil companies are, with a few other industries, foremost in the picture. They have long realized how essential it is to search for new methods of production and refining as well as for ways of further improving existing oil products and finding new ones.

By far the greatest share of this research work, demanding the constant expenditure of money on ingenious equipment and imaginative scientists, is carried out in the Netherlands by two oil companies, Royal Dutch Shell and Caltex, both of whom maintain contact with the experts of the various Universities in their country as also with those of the Netherlands Organization for Applied Scientific Research and other similar organizations.

Royal Dutch/Shell Research

Scientific investigations and research in the Netherlands for the various companies belonging to the Royal Dutch Shell Group of companies is carried out in three laboratories. The principal one is in Amsterdam. The continuous growth of this laboratory, which was established as early as 1914, is perhaps best exemplified by its increase of staff from 30 in 1920 to over 1,800 in 1958. This necessitated the erection of many new operational buildings, which have sprung up around the original nucleus now merely used as a training centre.

A second research centre is at present situated near Delft and was originally started in 1928 as an engine-testing laboratory. However, at present it houses two distinct laboratories, one handling exploration and production problems, which will move in 1961 to entirely new buildings under construction at Rijswijk in the vicinity of The Hague, and the other dealing with plastics.

The activities of these three Royal Dutch Shell laboratories still perforce deal with three aspects—those of the oil industry, chemical industry and fundamental scientific research.

The exploration and production laboratory possesses a staff of 300 engaged in one of the main tasks facing the oil industry: the maintenance of an uninterrupted and steadily increasing flow of oil to the refineries through the evolution of new and improved methods of exploration, as well as research into the fields of drilling, production and the physical problems encountered when studying the flow of oil in reservoir rocks.

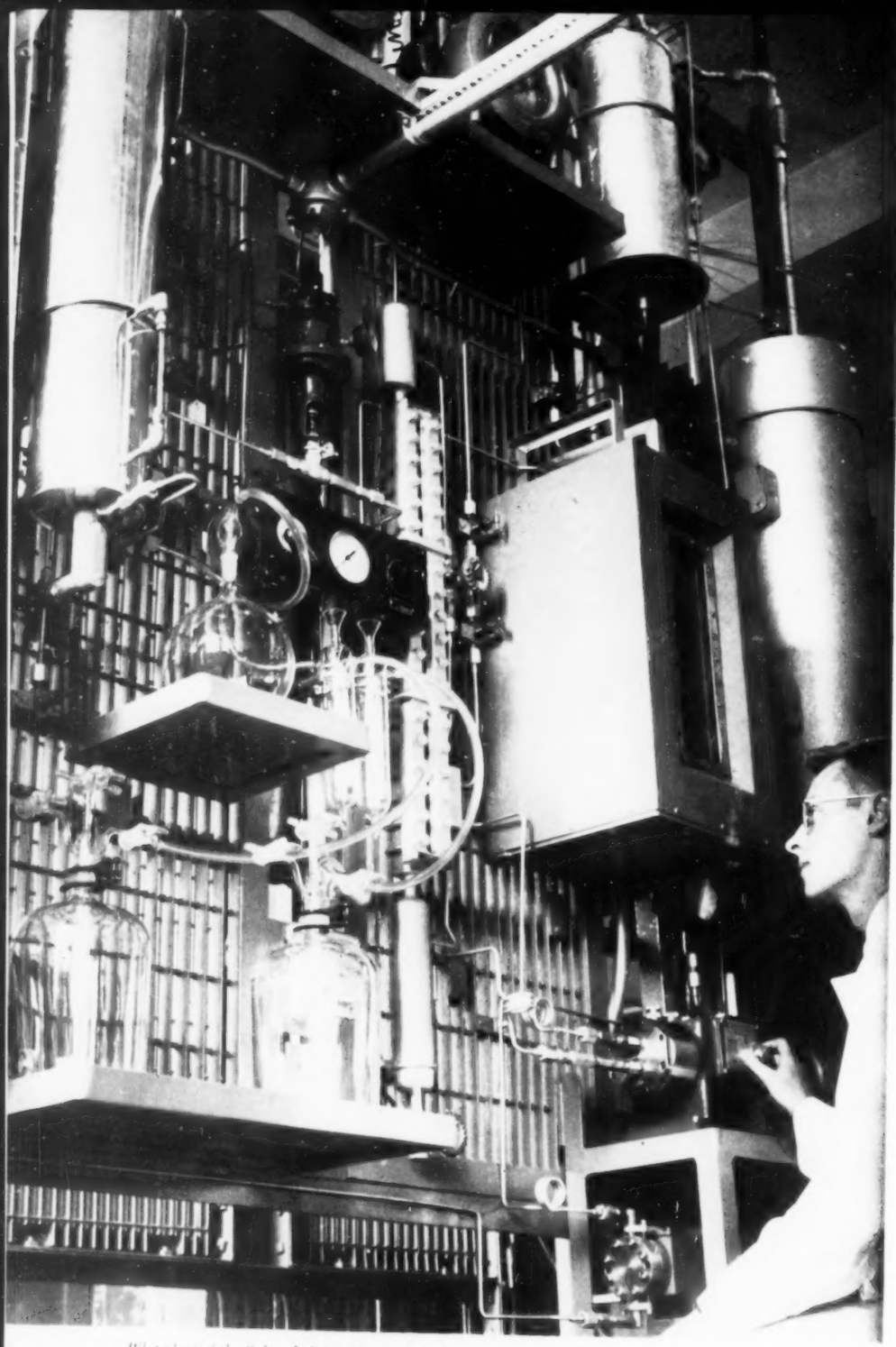
In Amsterdam research into processing methods is carried out partly in the laboratories and partly in pilot plants. The aim is to develop new refinery methods and improve existing ones, to achieve maximum output and enable the manufacturing and marketing side of the industry to adjust itself to the ever-changing needs of the market.

With the standards on the world market becoming more exacting and diverse, "product research" is indispensable. This is carried out not only in Amsterdam but also in the plastics laboratory. This laboratory, which will remain in Delft, will be engaged solely on the development and application of new and improved products in the fields of plastics, synthetic rubbers and resins, which work was started in 1957 and already occupies approximately 100 research scientists.

Since the beginning of the chemical industry based on oil, in the early thirties, the Amsterdam laboratories have been active in the fields of chemical products and processes. Furthermore, the Amsterdam and Delft laboratories also cover a wide range of fundamental research, necessary because of the increasing complexity of the problems of modern scientific research.

Another important research activity is the specialist training of staff for posts at home and abroad, as also the constant exchange of information and research workers between the laboratories of the Royal Dutch Shell Group of companies in various countries in order to promote scientific progress.

Royal Dutch/Shell laboratories at Amsterdam.



Pilot plant of the Caltex Laboratories at Rotterdam.

The Caltex Laboratories

One outcome of the Caltex policy of maintaining its products at the highest possible level of quality and of keeping its refineries operating at maximum efficiency, is the establishment of the Caltex Central Laboratories at Rotterdam. This new technical centre caters for all the different producing, refining, transportation and marketing companies in the Caltex-Group. It does not carry out any fundamental research, as is done in affiliated laboratories at Beacon, New York and Richmond, California: it concentrates rather on special technical service and development needs of the individual Caltex affiliates in Europe, Asia, Africa and Australia.

The facilities concentrated in Holland include a miniature refinery with a crude oil distillation unit, a catalytic cracking unit and a catalytic reforming unit, all of which permit evaluation of new crude oils and new catalysts and facilitate the developments necessary to meet future volume and product requirements.

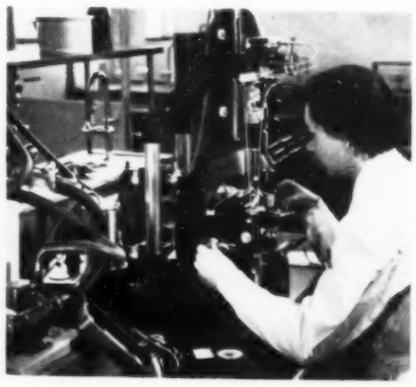
In addition to its "laboratory refinery" this centre also brings the problems of transportation on the oceans, skyways and highways of the world indoors in the form of a complete marine engine with dynamometer assembly, jet fuel heat-exchange and filtration simulation equipment, and an automotive all-weather chassis dynamometer. The latter, the first in Europe, has been specially designed for road-type testing of a wide range of sizes and powers of vehicles under controlled humidity at temperatures ranging from −30° F to +120° F and at speeds up to 100 m.p.h.

In addition to performing laboratory work, the Caltex Central Laboratories are also the headquarters of a technical service group charged with keeping abreast of new developments, analyzing automotive and industrial equipment fuel and lubricant requirements, and giving general advice on all aspects of modern applied research.

All-round Cooperation

From this brief description it should be clear that these Dutch oil laboratories are not static and self-contained units buried under a weight of scientific knowledge. There is a continuous exchange of problems, ideas and results between the experts in the laboratories and the oil workers in the different fields of activity, as for instance the production of crude oil, exploration and drilling, the supervision of refinery processes or the development of new chemical products and finally the selling of the goods. The men "in the field" are regarded also as research workers and are all a cog in the wheel of great organizations whose hub is in the laboratory but whose circumference extends around the world wherever oil is being searched for, found or transformed into useful products.

They are, indeed, part of a powerful world-wide team working together and achieving real results through investigation, trial and application, trying to solve problems as they arise, and always on the look-out for something new.



The Netherlands as a market for petroleum products

Economic development of the country with special reference to oil consumption

The Dutch market for petroleum products expanded threefold within the last decade; during this period world oil consumption doubled.

This is the result of post-war reconstruction and a rapid population increase. The resulting active economic development coupled with the basically changing pattern of the national economy, have together produced marketing and distribution problems of special interest. These problems should be viewed against the background of peculiar geographical features, which place so great an emphasis on water as a means of transportation (see chart on page 23). Some interesting details are given below.

I *Population increase*

Even when allowance is made for the fact that the Netherlands occupy the seaboard of one of the most densely populated areas of Western Europe (see chart on page 2), its population increase is quite remarkable. As appears from the chart below it rose by 22% between 1930 and 1950 and by a further 14% in the next seven years alone. The fact that the number of people engaged in agriculture has shown hardly any increase in the last 60 years is clear. The general changeover from an agricultural to an industrial pattern is depicted in the graph on page 22, which shows the changing pattern of employment of the economically active population of the Netherlands in the first half of the present century.

II *Growth of industry*

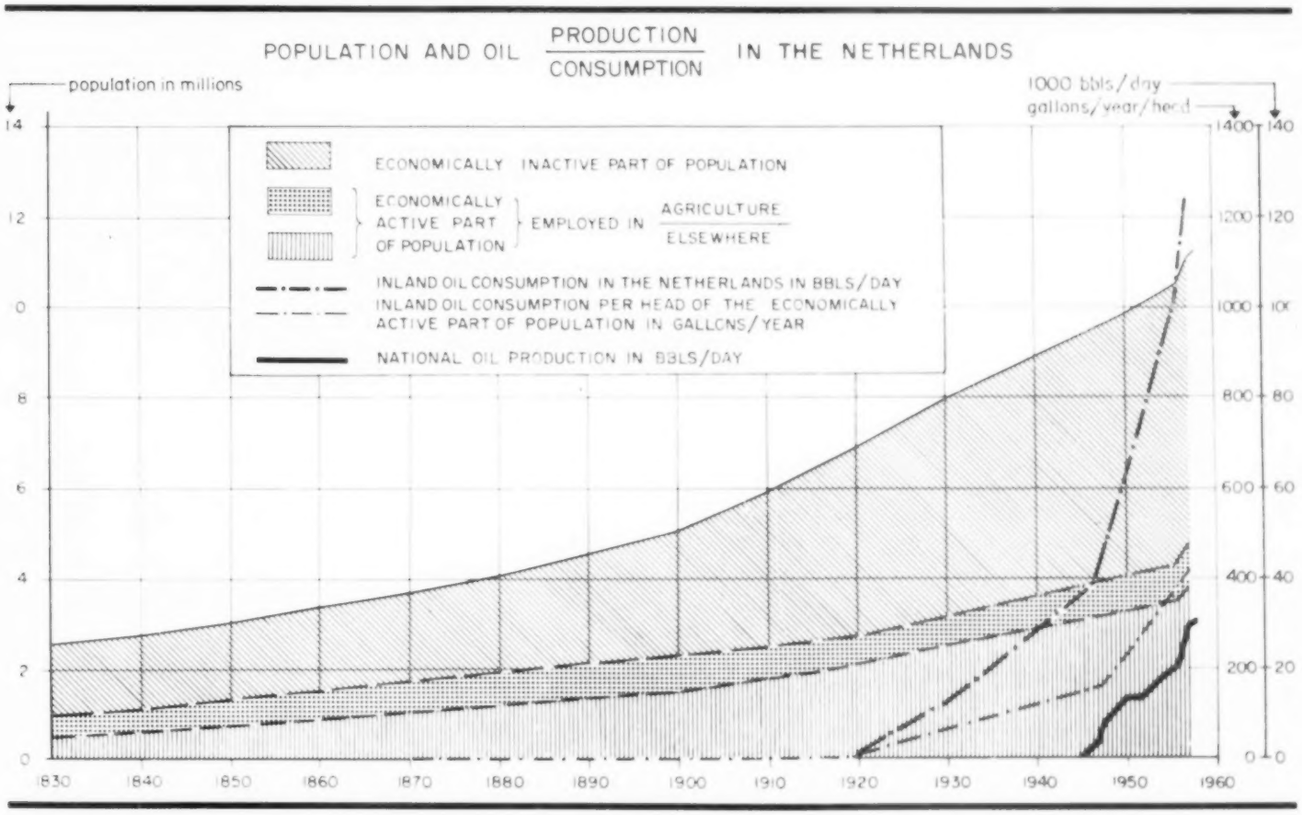
In combination, the two graphs on page 22 shed some interesting light on this development, showing as it does the trend of the composition of the national income between 1950 and 1957. The relative increase in the percentage derived from industry (44% in 1957 against 30% in 1938) as well as the actual amount (seven and a half times as great in 1957, as against an average five-fold increase) are the reward of purposeful industrialization. Over the period 1930-1950 the number of people employed in crafts and industry increased by some 70%, and by 1957 this number had risen by at least another 15%. A quite remarkable development is to be seen in the chemical and steel industries, where employment has tripled since 1930.

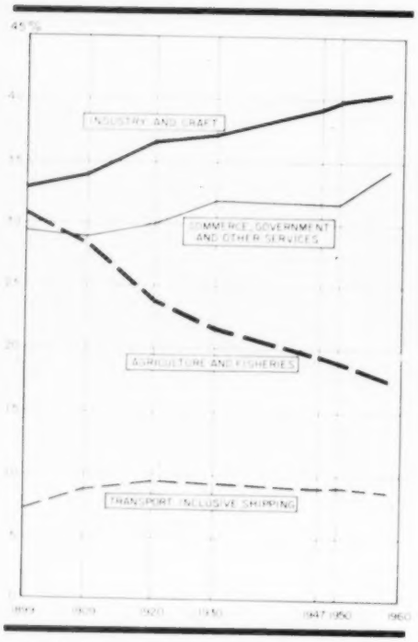
III *Increase in productivity*

Taking 1953 figures as 100, the index of the volume of industrial output at comparable prices was only 62 in 1938 but reached 126 in 1957. Corresponding indices denoting the production per employee are 95, 100 and 115 over 1938, 1953 and 1957 respectively. However, it is not only in industry, but also in agriculture that productivity has increased. Notwithstanding a decrease in acreage under cultivation (from 5,738,850 acres in 1938 to 5,678,415 acres in 1957) output has risen, thanks to increased productivity per acre.

IV *Power consumption rise*

It must be realized, however, that the Netherlands are short of raw materials from natural resources, as their only mineral deposits are salt, coal and crude oil, of which only salt is produced in sufficient quantities to cover the home demand and allow for ex-





port. Consequently Dutch industry is of a predominantly manufacturing character and its rate of power consumption is high.

That this development of industry and of transport and commerce as well as the mechanization of agriculture caused a considerable increase in power consumption, has been explained at length in Chapter I. The chart on page 21 clearly depicts the important part which oil as a source of power played in this development: oil consumption tripled between 1947 and 1957, whilst liquid and gaseous fuels cover at present approximately 40% of the country's primary power needs, compared with a mere 15% just after World War II.

V *Growth of commerce and transportation*

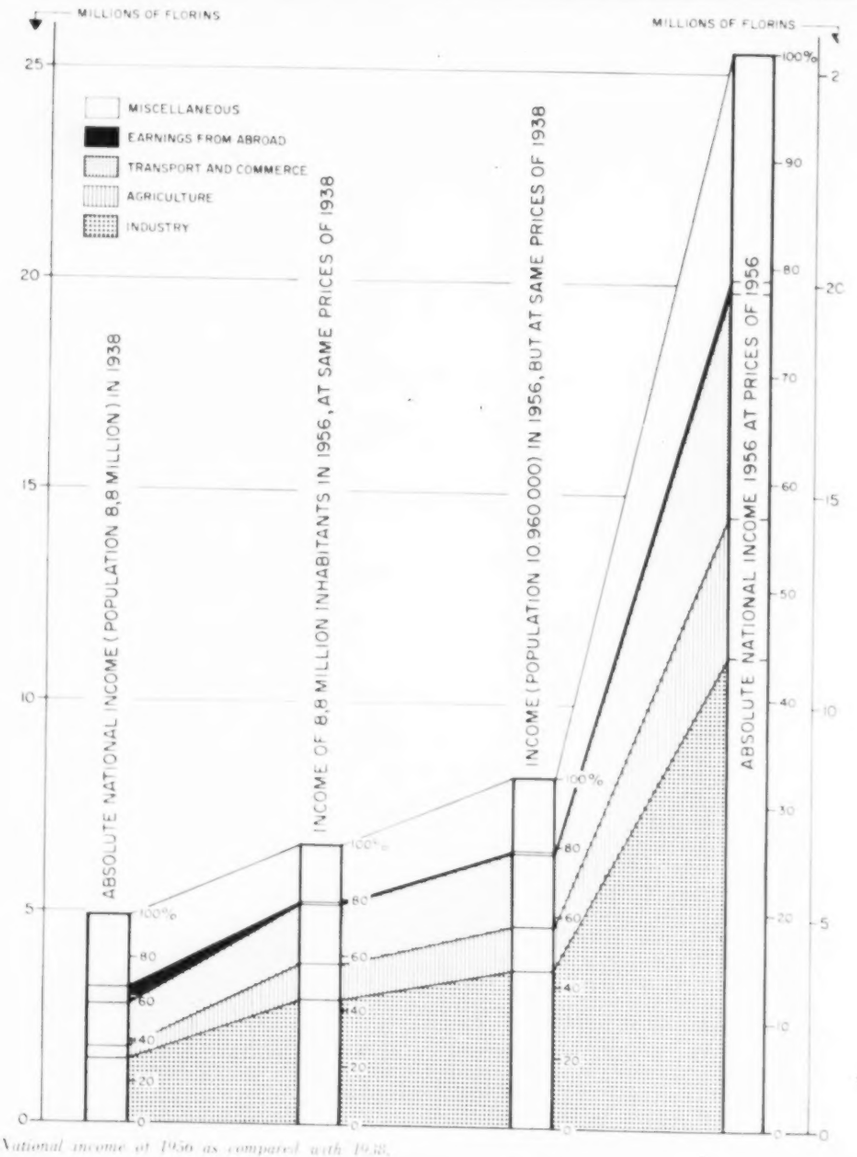
It is the fields of commerce and transportation, of course, that the Netherlands profit from their special geographical location on the West-European seaboard (cf. graph on page 2), which has given Holland a key position in European trade with the rest of the world.

It is therefore not to be wondered at that ocean going shipping and the Dutch mercantile marine are valuable assets to the country's earning capacity. Next, inland water transport, whether transit to foreign countries or purely national, is more intensive than in any other country in Western Europe (cf. chart on page 23). It follows from the internal physical make-up of the Netherlands, including so many rivers supplemented by man-made canals, that freight is predominantly water-borne. The growth of the national industry intensified this inland shipping within the national boundaries, as is perhaps best exemplified by the fact that of all freight transshipped in Rotterdam in 1938 only one quarter and in 1954 50% was destined for home use. Indeed, transport and commerce maintained between 1938 and 1956 their percentage contribution to the total national income, whilst actual figures rose more than five-fold, keeping pace with the country's general rate of economic expansion.

VI *Inland water transport*

Water transport, economically advantageous, is far more highly developed in the Netherlands than in almost any other country. This appears from the fact that there no less than 17% of the total length of transport arteries—railways, roads, rivers and canals —consists of waterways. In other countries such as the United Kingdom, France or Belgium, the corresponding proportion is only 2%. This explains why transport by barges is so widely used on the extensive network of Holland's waterways.

A noteworthy feature is that the carrying capacity of barges has gradually increased. Self propelled barges with a carrying capacity of up to 2,200 tons and towed barges of up to 3,000 tons in tows of six or more at a time travelling at a speed of some 12 mph conveyed as much as some 32,000 million


MILLIONS OF FLORINS
MILLIONS OF FLORINS
MISCELLANEOUS
EARNINGS FROM ABROAD
TRANSPORT AND COMMERCE
AGRICULTURE
INDUSTRY
ABSOLUTE NATIONAL INCOME (POPULATION 8,8 MILLION) IN 1938
INCOME OF 8,8 MILLION INHABITANTS IN 1956, AT SAME PRICES OF 1938
INCOME (POPULATION 10 960 000) IN 1956, BUT AT SAME PRICES OF 1938
ABSOLUTE NATIONAL INCOME 1956 AT PRICES OF 1956

National income of 1956 as compared with 1938.

A mere couple of hundred yards from a filling station in the vicinity of Rotterdam, the search for oil is in full swing.

tons of freight to and from the port of Rotterdam alone in the year 1957 (figure on page 23). Another important factor in oil consumption is that almost the entire inland fleet is nowadays diesel driven.

VII *Railways*

Whereas in the United Kingdom the railways represent 28% of the total length of all British transport arteries, in the Netherlands they account for only 7%, a figure that is still higher than in France and Belgium, where railways account for only 5% and road transport predominates. As in the Netherlands distances are generally short, water transport relatively cheap and freight trains capable of carrying no more than 1,200 tons at a mere 25 mph, rail transport is secondary to that by water for freight, and concerns itself primarily with passengers. Indeed, the current schedule of at least hourly trains connecting all the more important places in the Netherlands by fast electric or diesel trains can satisfy even the hardest pressed businessman. On the other hand, railways stimulate road passenger transport as they are implemented by a wide and integrated system of State, provincial or municipal buses.

A final interesting point is that the Dutch railways are the first on the continent to have done away with (coal fired) steam traction.

VIII *Road transport*

After all that has been said about railways and water transport it is understandable that there are only 30 private cars to every 1,000 inhabitants in the Netherlands, as compared with no less than 323 in the United States, 80 in France and 76 in the United Kingdom. The figures for commercial vehicles on the same basis are 12, 65, 24 and 33 in the Netherlands, United States, United Kingdom and France respectively.

Nevertheless road transport is growing fast, partly due to the spreading of industry away from the western seaboard; it is remarkable that since World War II industry does not "go to town" but instead "to the country" near centers of surplus population of rural origin. The western seaboard becoming congested, industry was obliged many years ago to settle inland, but did so mainly along railways and canals. However, improved road conditions and the relatively cheap possibilities of road transport, coupled with a shortage of housing in many towns (due to the stagnation of building during World War II) induced the industry to settle in rural areas, thus again stimulating road transport—of laborers by bus, and of fuel, raw materials and finished products by truck.

Fast, convenient train and bus services are supplemented in the case of the average Dutchman by the bicycle. Favored by the flatness of the countryside, the Dutch have always been a nation of cyclists and the opportunities of faster travel afforded by the moped or "buzz-bike" have opend up a new field. In 1948 there were only about 4,500 of these vehicles in use in the country; today there are almost a million, accounting for about 6% of the gasoline consumption. A wide net of well paved cycle paths has been laid in the country, and along the main highways one finds two special tracks for bicycles and "buzz bikes" which ease congestion and enhance road safety.

And then there is a growing tourism, which in 1938 brought barely ƒ 6 million worth of foreign currency into the country. This figure rose to about ƒ 170 million by 1953 and ƒ 230 million by 1956. Besides foreign visitors, the Dutch themselves are travelling more and more in their own country, as a result of a rising standard of living and expanding social amenities such as paid vacations.

In 1957 the Dutch spent ƒ 500 million on travel within their own country; and as increasing use is being made of automobiles, buses and mopeds, this side of tourism creates a growing market for gasoline.

Growing demand for petroleum products

It will be clear from this survey of economic developments that there is a rapidly growing home demand for petroleum prod-

(Taken from: Oslo verslag europese wet- en regelgeving Europese Unie Brugge)

ucts. The figures for 1957 are given below.

Consumption in the Netherlands, 1957 (excluding chemicals and town gas)

	No. of barrels in millions
Gasolines	8.5
Illuminating kerosine	2.1
Black oils	
Traction / Heating \	5.9
Industry	17.0
Lubricants	0.8
Bitumen	0.9
Aviation products	1.7
Liquefied gases	1.2
Total	38.1

At present industry provides by far the largest outlet for oil and its many products. The original trade in this sector was in industrial lubricants and although this type of trade is still steadily growing and demanding specialized knowledge, the most remarkable development in the industry field is the rapidly increasing demand for oil as source of power.

A quarter of a century ago sales of black oils for use in industry represented less than 20% of all petroleum products sold. Consumption by industry had jumped from over 1 million barrels to 17 million in 1957, amounting to about one half of the total home demand for petroleum products.

The more intensive use of petroleum products as a source of power for industry is readily explained by both the favorable prices for petroleum fuel as compared with coal prices, and the many technical advantages of oil.

The mechanization of agriculture and horticulture is reflected in sales of fuels for tractive power. Although in the past farmers have rather militated against the use of much mechanization, a nation wide reallotment plan combined with an educative campaign resulted in a fairly rapid increase in mechanical traction in relation to total tractive power employed. The proportion of mechanical traction has in fact doubled in the past seven years from 23% to 47%.

The growing use of diesel engines in the field of transport has already been mentioned. The use of diesel oil as a motor fuel expanded markedly in the post war period, while that of liquefied petroleum gases is rapidly increasing.

A very important factor is ocean going shipping, accounting for the supply of over 14 million barrels of bunkering oil in the Netherlands every year. Aviation fuels are also valuable products supplied not only to the K.L.M. (Royal Dutch Airlines), but also to all the many other world lines that use the international airport of Schiphol near Amsterdam.

Also in the domestic sector the use of petroleum products opened up various new markets, including the use of oil for heating. According to official estimates the use of liquid fuels for domestic power and heating may rise from the present 14% of total domestic power consumption to 36% within the next 20 years whilst the use of solid fuels in this field may fall from 70% to 37%. Liquefied gases are also finding a ready sale on the domestic market in the Netherlands, mainly for cooking and heating.

The spectacular development of the petrochemical industry gives these petroleum based products an ever increasing percentage of the total chemicals market. Agriculture constitutes an important market for a wide range of biocides, of which about one third are now based on petroleum products. The growing use in industry of synthetic detergents, plastics and other products such as alcoholic and ketonic solvents, is also deserving of mention.

Finally, the rapid replacement of most of the old Dutch brick roads by asphalt roads results in a steadily growing use of bitumen.

Distribution of petroleum products

Passing now from the demand side to the supply side, it can be stated briefly that the products for the home market are mainly obtained from the Pernis refineries, the balance being imported from abroad.

There are three large marketing companies—Shell, Esso and Caltex—as well as several smaller sellers such as B.P., Purfina and Gulf.

The two main features governing the transportation activities of the market supplier in the Netherlands are the short distances and the many waterways. Supplies are concentrated in the two principal ports of Rotterdam and Amsterdam, and then distributed to the inland market either directly to customers (from the refineries) or through intermediate storage points.

Road, rail and water transport are all used, the cheaper water transport being chosen wherever possible.

Large barges are used to convey products in bulk to depots and, wherever possible, directly to customers. In certain cases, deliveries are made by barges to the nearest location completing the delivery with bulk lorries to the customer. Bulk trucks are used intensively for delivering from depots to customers as well as for the supply of such products as bitumen and chemicals from the refinery. Smaller package deliveries, mainly tins and cases, are mostly farmed out to third parties.

In the Netherlands deliveries of products by rail tank car are of minor importance, but combined with road tankers are indispensable in ensuring continuous delivery when waterways are icebound in winter.

As for the future, it may be confidently stated that the already expanding Netherlands market for petroleum products is now reaching a new stage in its development. It is hoped that the economic integration aimed at by the European Common Market may give a further stimulus to the Dutch economy which will make itself felt in a still greater demand for oil. Marketing companies are generally hopeful about the future.

Bitumen being used to cover the dikes which protect Holland against the sea.

Drilling contractors incorporated in the Netherlands

Nederlandse Boormaatschappii N. V.

A Drilvo crew cementing the wall of a bore hole.

The first of the oil well drilling contracting concerns to establish itself in Holland was the Nederlandse Boormaatschappij N. V. This company was founded in June 1953 as a joint undertaking by the Drilling and Exploration Co., Inc., of Dallas, Texas, experienced oil well drillers and the first U.S. contractor to enter the international field, and the Koninklijke Maatschappij tot het uitvoeren van openbare werken "Adriaan Volker" (Royal "Adriaan Volker" Company for the execution of public works).

The head office of the Nederlandse Boormaatschappij N. V. is in The Hague.

During the very first year of its existence this company (called "Drilvo" for short) made a start on its task in the Netherlands—that of drilling under contract—largely in the east of the country.

Drilvo operated continuously from 1953 to 1958 in the Schoonebeek oilfield, where its chief occupation was the drilling of production wells and general care of wells. Here it used the equipment of the Nederlandse Aardolie Maatschappij under a labor contract between the two companies.

In 1954 Drilvo looked beyond the Netherlands frontiers. They went into Nigeria with a deep well rig, and in three years two additional deep well rigs were added. 32 "wild cat" and development wells have been drilled for a total of 304,186 ft. Drilvo rigs were also operated in Italy, Sicily and in France.

Drilvo has the respectable number of 111 drillings in the Netherlands to its credit—some being exploratory holes, but the majority for production wells at Schoonebeek. No less than 84 of the 111 proved to be oil producing, and five gas producing. Twelve holes were dry, and the total includes ten water injection wells sunk at the edge of the Schoonebeek field. Altogether 338,508 feet of hole have been drilled.

Two additional holes were drilled by Drilvo for the Koninklijke Nederlandse Zoutindustrie (Royal Dutch Salt Industry) near Winschoten in the north, with a total footage of 9,414 ft.

On this showing, the Nederlandse Boormaatschappij N. V. has plainly done its bit towards promoting the industrialization of the Netherlands, by supporting two important companies in their exploration programs for such widely divergent minerals as oil and salt.

At present, Drilvo has 111 drillings in the Netherlands to its credit.

International Drilling Co., N.V.

One of the most remarkable young companies of Holland, devoted to the petroleum industry, is the International Drilling Co., N.V. (Internationale Boor Maatschappij). The managing directors of this company are Monty G. Garrison and Wallace W. March. They have been active in contract oil well drilling over 25 years and have a wealth of experience drilling oil wells throughout the Middle East, Africa, North and South America.

On October 31, 1955, International Drilling Co., N.V. was formed with headquarters in The Hague, Holland. The first drilling rig arrived in early March 1956, and its first task was the completion of three wells in North Holland for the production of salt for the Koninklijke Nederlandse Zoutindustrie. The rig then moved to the Pijnacker Field in Western Holland and began drilling for oil production for N.A.M. This rig has ever since been in continuous service for N.A.M. and has drilled 16 wells, representing 117,640 feet of hole; of these, 20 wells were commercial producers and four were dry holes. This rig, a National Ideal II, has been unitized so that a minimum of surface location is required. This is a very important factor in Holland due to the density of the population and the resulting value of surface property to the economy of the country.

With this modest beginning International rapidly expanded its operations into England, Africa and the Middle East, and at present is operating twenty rigs. In May of 1956 a complete drilling operation was landed on the shores of Italian Somaliland by the use of specially constructed portable barges. All equipment was unloaded from a chartered ship standing four miles at sea onto these barges and the barges propelled to the beach by specially rigged outboard type engines and propellers. This was indeed a first in the method and in the efficiency of putting such a quantity of equipment ashore on a barren beach with no semblance of port facilities available. This rig is of the 16,000-ft class. The total operation is self-sustaining to include complete portable camp system, heavy and light transportation system, warehouse and supply system. This rig is still drilling in Italian Somaliland. Last year this rig drilled a hole in excess of 16,000 ft which record still stands as the deepest drilled hole on the African continent.

Across the African continent in Nigeria, the company is operating two 16,000-ft drilling rigs also complete with all camp, warehousing and light transportation equipment. These rigs are drilling for Shell-B.P.; they have set up a new pattern for contract operations in Nigeria in that the footage drilled is contracted for on an incentive payment basis. International is supplying a self-sustained package operation in Nigeria.

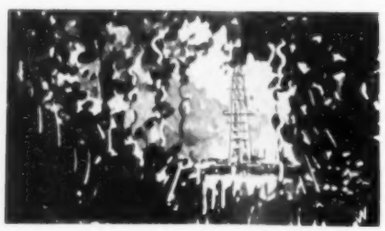
In British Somaliland International Drilling handled the complete drilling program for Amerada Petroleum Corp. concessions there. International is now operating this same equipment in Libya under the auspices of the Conorada Group, Oasis Oil Co. being the operator. This will be the fourth rig in operation for the Oasis Oil Co. in Libya.

International Drilling Co., N.V. has so expanded in Libya that this area has been organized under the supervision of a general manager. In addition to operations for the Oasis Oil Co., International has two rigs for Amoseas and one rig for D'Arcy Exploration Co. (Africa) Ltd. For all of these operations the company offers its usual complete service for its clients.

In the Middle East International is operating five strings of tools on land and has recently set up offshore operations in the Persian Gulf. In the Sheikdom of Kuwait the company has two 15,000 ft drilling rigs operating for Kuwait Oil Co. in the Rhadatain Fields. These two rigs are unitized for skidding across the desert on Athey tracks. The efficiency and perfection of this system of moving can be appreciated when one of these complete rigs and associated equipment is moved several miles to new location and spudded on the next well in a period under thirty hours. Supporting these rigs International has a complete desert camp, warehouse and supply system. Another first for International in contract drilling in the Middle East is this contract, in that drilling is conducted on a straight footage rate type of contract, International furnishing all supplies.

Across the Persian Gulf, International is operating three drilling rigs in the Gach Saran Field for The Iranian Oil Exploration Producing Co., N.V. ("The Consortium"). This area holds some of the most troublesome and difficult drilling conditions in the world. International Drilling has concentrated in this area an extraordinary array of supervisory and engineering talent specially selected for experience and ability in handling high pressure, heaving shale, and saturated salt drilling conditions.

The Arabian Oil Co. holds concessions offshore of the Neutral Zone between Saudi Arabia and Kuwait. The Arabian Oil Co., a newcomer to this part of the world, selected International Drilling to develop its concessions because of the company's experience in this area and most particularly because International could offer a complete package deal to furnish and operate all equipment, supplies, purchasing, shore base facilities and supporting services. Only a skeleton staff of top level supervision is being maintained by



The Arabian Oil Co.: under general directives International Drilling is handling its complete offshore drilling operation. In addition to the extensive shore base facilities established in the Neutral Zone, International has in excess of $6 million worth of marine drilling equipment in supporting vessels. The mobile drilling platform, "The J. C. Thornton" is a Le Tourneau unit of the latest design. It has been reported that this is the largest single drilling contract in terms of

gross money involved that has ever been concluded in the oil industry.

International Drilling is the largest contract drilling company in the Eastern Hemisphere. From its modest beginning in the Lowlands of Holland, through its rapid expansion throughout Europe, the Middle East and Africa, is a success story bordering on the phenomenal. The company now maintains a complete operational staff in Rome, Italy, from which all of its operations are readily accessible in a matter of hours by direct air flight. Probably the greatest factor contributing to the fantastic success of this company has been the concentration of exceptionally capable and experienced drilling engineering talent at operational headquarters staff and the fact that this supervision continually inspects each field operation and demands the highest standard performance.

The International Drilling Co., N.V. maintains administrative control of its worldwide organization from its offices in The Hague, Holland. The company has found a wealth of encouragement and advantage, both from the Government and business associations in Holland. Truly, the Netherlands is proud of this young company which has pushed its enterprises to three continents. From its offices in The Hague, International Drilling Company, N.V. is administrating a worldwide enterprise which is truly in keeping with the best traditions of the peoples of the Netherlands.

The Royal Dutch Salt Industry

The N.V. Koninklijke Nederlandsche Zoutindustrie was founded on July, 1918. A plant designed to produce 30,000 metric tons of common salt annually was started at Boekelo, a village six miles from Hengelo. The salt, which is situated at a depth of 1,000 to 1,250 feet, is recovered by underground leaching. Initially the brine was evaporated in so-called grained pans by means of the heat of circulating flue gases from a coal fire. A few years later a more economical production system was introduced, based on the evaporation of brine in a vacuum plant.

A new plant was erected at Hengelo in 1937, in view of the construction of a canal which was to connect Hengelo with the main waterway system of Holland, thus making it possible to economize on freight.

Output has been rising continuously, especially since the war, and now totals 800,000 tons of vacuum salt. A considerable proportion is exported to Scandinavia and many other countries all over the world. The outstanding properties of the salt, its low content of sulfate and insoluble components and the fact that it is non-caking, make it especially suitable for electrolysis plants. Some 90% of the needs of the electrolysis plants in Belgium, Scandinavia and Holland is met by the Royal Dutch Salt Industry. Another product which is increasingly popular, is the trace mineral saltlick for cattle.

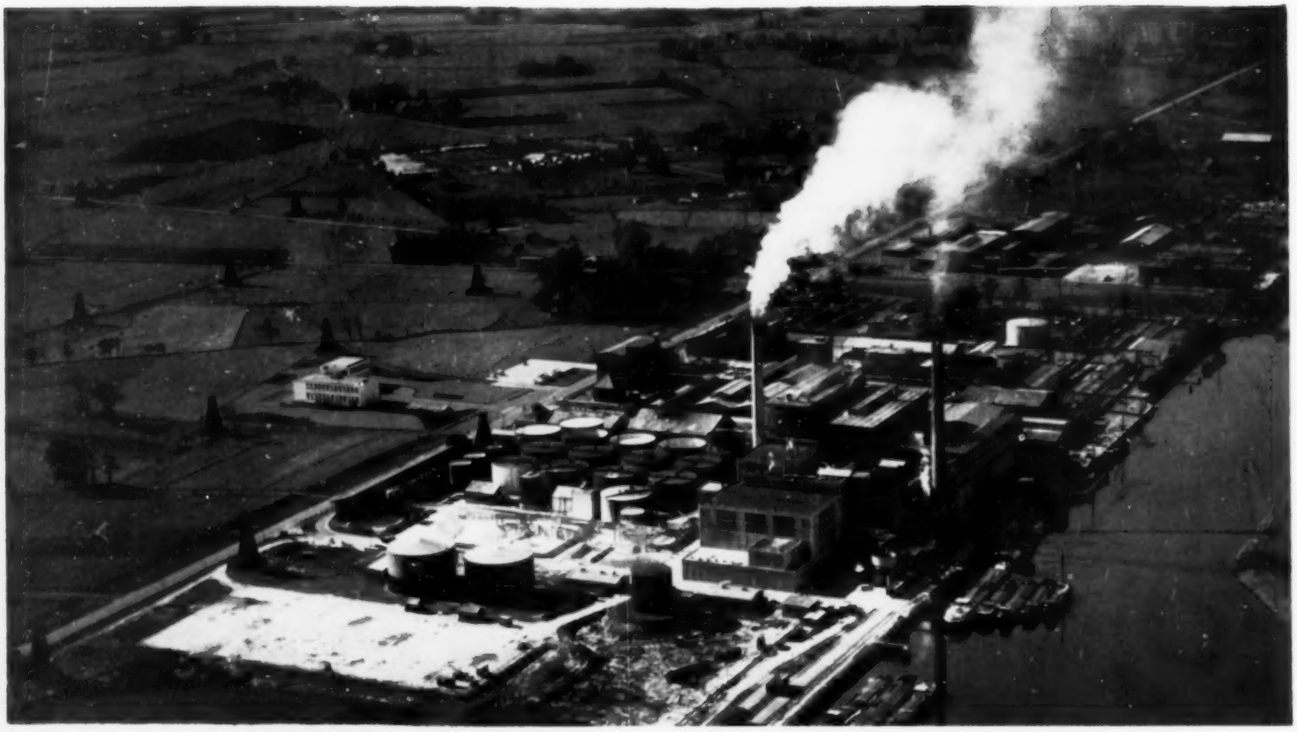
In 1931 an electrolysis plant was erected, in which a solution of pure salt is converted into chlorine, caustic soda and hydrogen. Part of the production is used to make bleaching lye and hydrochloric acid. Later on, copperoxychloride (a fungicide) was added to the production program. The total output of the chemical plant of the Royal Dutch Salt Industry is now about 150,000 tons of chemicals a year.

In 1954 the assets of an adjacent chemical company were acquired and transferred to the Exploitatie Maatschappij Stork-Chemie N.V. (Stork Koninklijke Nederlandsche Zoutindustrie). The production program of Stork-Chemie is mainly confined to monochloro acetic acid and an intermediate for the production of different commodities.

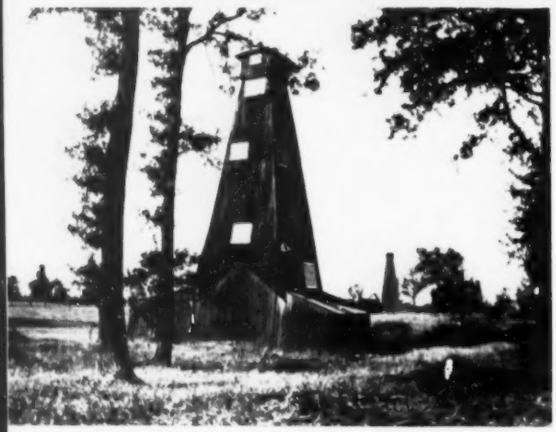
A new plant for the production of amino acetic (glycocoll) for pharmaceutical and synthetic purposes was recently started. The further expansion of Stork-Chemie will be mainly in the field of chlorination chemistry.

In 1952 a salt dome was located at Winschoten, a town in the North-East of Holland, 16 miles from the seaport of Delfziji.

I.D.C. drilling rig for the search of salt.



The salt plant, flanked by water and by salt derricks, in the characteristically flat Dutch landscape. A close-up of a derrick is shown at left.



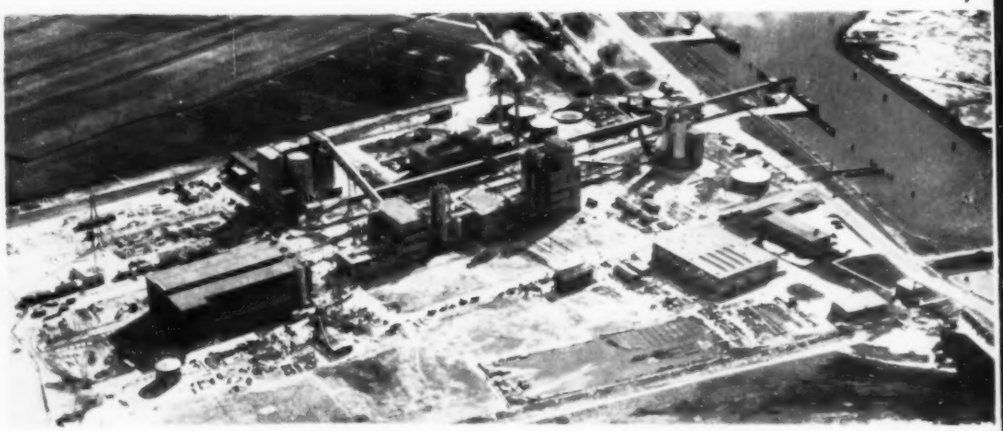
This location was the successful result of geophysical exploration and drilling performed by the Nederlandse Aardolie Maatschappij at the request of the N.V. Koninklijke Nederlansche Zoutindustrie. The latter company acquired the exploitation rights of the salt dome.

Hitherto the problem of waste disposal had prevented the founding of a soda ash industry in Holland; the discovery of the salt dome not far from the sea opened up new possibilities. In August 1954 the Dutch Soda Industry Ltd. was founded. The factory at Delfzijl went into production at the end of 1957. The brine required at Delfzijl is supplied by the salt dome at Winschoten and is transported through a pipeline.

In connection with the growth of a large petrochemical industry in Holland, chlorine requirements are rising. Therefore the Koninklijke Nederlandsche Zoutindustrie erected a second electrolysis plant at Delfzijl, adjacent to the site of the soda ash industry. At the same site the company is building a new vacuum installation in order to meet the ever-increasing demand for its salt. This factory was planned for 1959 production.

In 1958 the total capital stock of the N.V. Electro Zuur-en Waterstoffabriek (Electro Oxygen and Hydrogen Works Ltd.) was acquired. The production program of this plant contains the following products: carbide, dissolved acetylene, acetic acid, vinylacetate, tri-perchloroethylene, oxygen, argon, etc.

This company has a subsidiary in South Africa, the Holland Chemical Industries Ltd. at Johannesburg, which produces acetic acid, oxygen, acetylene, calciumacetate and vinylacetate.



The soda works at Delfzijl.

Holland and its oil equipment

Holland as an industrial country

When Rembrandt painted his "Staalmeesters," the Syndics of the Amsterdam Cloth Guild, in 1662 he depicted the genuine Holland of the Golden Age. This "College of Approval" of Amsterdam's first and most important guild was responsible for the good name and fame of Holland's industry. In those days the costly cloth which was dyed and treated in this country bore witness to the technical ability and the industry of those people who, in the Low Countries, had earned the name of Netherlanders in their constant battle against the sea.

Yet even at that time the manufacture of costly woolen materials in Holland was already centuries old. When Charlemagne wanted presents for Haroum al Raschid from the best his empire could offer, he selected Frisian woollen cloth. Frisia then was the name given to the whole area that later became Holland; and thus it was that, through the centuries, Frisian diligence, the activity of the Norsemen, and the determination of the Angles (who also put their mark on the character of the English) jointly gave a basis to the way of life of the inhabitants of the Low Countries and the foundation of the industrial character of the present-day Netherlander.

There were, of course, also the farmers, dependent on weather and nature, and perhaps more placid than industrious. On the other hand there were the seafarers, merchants and traders who took Holland's name to the four corners of the earth and paved the way for industrialization. That the whole of the Western European trade in the time of Charlemagne was dominated by traffic between the ancient Rhine town of Dorestad in the Netherlands and Haithabu in the land of the Angles in Jutland can only be explained by the technical inventiveness and diligence of the shipbuilders and wool-weavers of Friesland and Holland.

At the present time exports from the Netherlands, with just over 11 million inhabitants, represent about 40% of the national income. And of this export, not less than 75% consists of products of Dutch industry. And although this "industrial revolution" is outwardly of recent occurrence, in effect it is the outcome of Dutch history. The Dutchmen of today are a diligent people; in the 15th century diligence was used in the Bible in the sense of seriousness, which certainly applies to the Dutch through history.

Even the mercenaries hired into service with the Dutch troops against the Spanish in the Eighty Years' War complained that it was anything but fun, especially as the clergymen accompanying the armies forbade pillaging or stealing and insisted on chivalry towards women.

It was on this foundation that Dutch industry has been built, often developing on the old techniques indigenous to the country and its people. For example, the textile industry, one of the oldest, was reborn in the 19th century and shipbuilding has a history in the land dating back 2,000 years. Then, too, the perpetual contest with the water: the construction of dikes and the land, the laying of canals and the erection of bridges, all formed the basis of the great engineering industry that has arisen in the past century or so and which today forms an important part of the country's economy.

History has no beginning and no end: the roots of what exists today go back to former centuries, which in their turn were shaped by the experiences of earlier days, back to a distant past.

As an example, the Dutch metal and machine industry grew up the first half of the previous century in close connection with the existing shipyards which, when wooden ships gave place to iron vessels, founded their own iron and steel departments. And although the first steam engine in the Netherlands was installed in a textile factory, it was the prominent shipbuilding industry that taught Holland her mastery of the steam engine. In this way Dutch industry grew up in two directions: the textile industry wanted machines and equipment and along the coast, in the west, shipbuilding became a metal-working industry.

A special characteristic of Netherlands industry is the important role played both in the past and in the present by foreigners seeking refuge in the free Netherlands.

In the 17th century refugees from France, Belgium, and later Germany and the Walloon people, set up enterprises and made the utmost use of the country's geographically strategic position and the diligence of its people to help build up an industrial tradition.

Since the last war, a similar development has taken place though not now catalyzed by refugees. In the past ten years 124 daughter companies of foreign industrial enterprises have been establishd in the Netherlands, 69 of which were of American origin. In addition, 117 foreign concerns have become affiliated with Dutch industries.

The phenomenally rapid growth of Dutch industrial production and the spectacular expansion of exports in the past decade, coupled with the magnitude of foreign participation, may be attributed to several causes: the rapid growth of the population necessitating

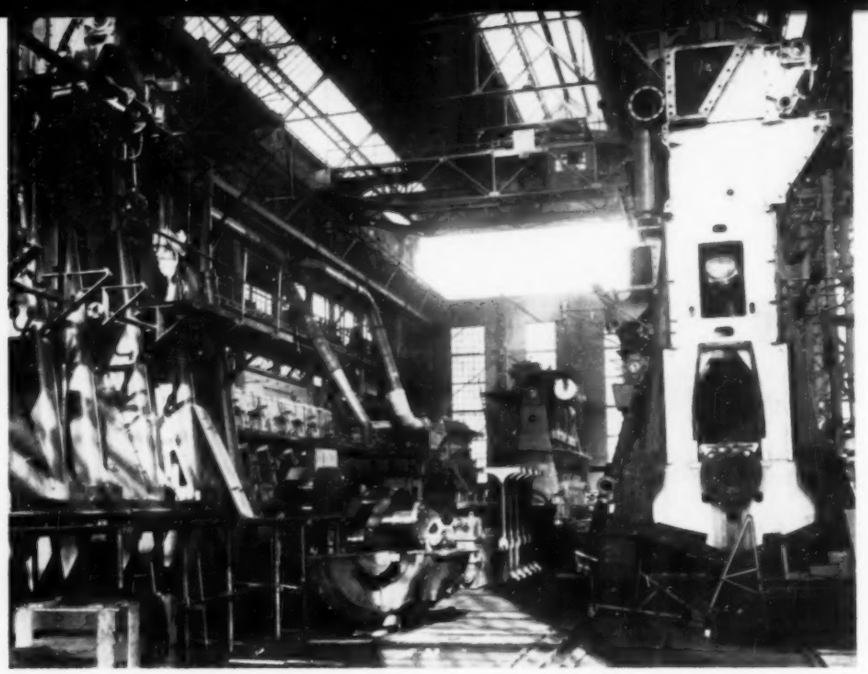
an intensification of industry for both employment and supply; the loss of Indonesian raw materials and markets; the favorable industrial climate produced by the economic policy of the Government which includes the encouragement of investments and the promotion of industrial expansion by suitable fiscal measures; and, last but not least, the joint achievement of workers and employers in producing peaceful labor relations. Behind all this, there has also been the determination to raise the living standard by stepping up productivity and stabilizing the cost of living.

Parallel to this industrial progress there has been the striking expansion of scientific activity. Especially in the past 75 years Dutch scientists, notably physicists, have attained world-wide repute through men such as Lorentz the forerunner of Einstein, Van der Waals, Zeeman, Kramers and Debye, all of whom are Nobel prizemen.

This has had its effect on general education. A century ago technical education in Holland attracted only 1.5% of pupils in the age group between 13 and 18 years; today almost 40% of this age group are studying technical subjects. In the middle of the 19th century less than 0.4% of the youth between 19 and 24 years studied at the university; today that figure has risen to 4%, of which more than a half are pursuing scientific studies.

Research today, especially for industry, is a vital feature of Dutch life. In 1932 the Netherlands Central Organization for Applied Scientific Research (T.N.O.) was set up to provide cooperation between the government, science and industrial life. Nowadays this central institution has grown into a comprehensive organization in which (with a tenfold increase in its budget) the industrial section covers 26 institutes and laboratories.

Dutch industrialists have not been slow to seize the opportunity to apply the findings of modern science to their own activities. A typical example of this was the position of shipbuilding in the second half of the past century. Threatened with growing foreign competition based on the more intensive use of new engineering techniques, Dutch shipbuilders quickly followed suit, with the result that they have been able to maintain and even improve their world-wide position. It takes many years for a trained ship designer to draw the blueprints of a seagoing vessel in every meticulous detail; nevertheless the experienced designer will readily adapt himself to new developments and techniques arising from scientific research. The Dutch shipbuilding industry, with a practical experience of centuries married to modern developments is taking great strides and making an important contribution to the nation's economy.



Large marine Diesel engines under construction at the Amsterdam Works of Werkspoor N.V.

At the moment industry represents 44% of the national income; agriculture, trade and transport together contribute 32%. Before the war these proportions were 28 and 30 respectively. Industrial exports are now three times greater than exports of agricultural produce.

In the past ten years the total national production of the Netherlands has increased by 56%, whilst the industrial production has gone up by 79%. Of the working population 56% are employed in industry. The rapid growth of the population, at an average of 1.4% a year, the greatest of any Western land made the expansion of industry a necessity, in order to give employment to the growing labor force.

There was also the fact that as a result of the war and the events in Indonesia the Netherlands balance of payments was badly situated on the debit side, so that new sources of income just had to be found. Before the war Holland obtained 10% of its national income from foreign investments; immediately after the war this dropped to 3%. Moreover, the income from Indonesia has gone and the Dutch investments there, estimated at $1,300 million, have either been seized or put in a very precarious position.

However, Indonesia has been invaluable as a market to nurture many Dutch industries. A quarter of a century ago 66% of the Dutch metal industry's production was for Indonesia. This market, it is true, has now completely disappeared, but the industrial experience gained there remains and now finds an outlet in new activities all over the world. For example, Dutch enterprise is responsible for new palm oil factories in Africa and Asia, and the experience gained in Indonesian oil fields since 1890 is now used to the benefit of the world oil industry.

Because of a low level of costs the average hourly wage in the Netherlands for skilled labor in 1957 was calculated at $0.48, as against $0.64 in France, $0.59 in Western Germany and $0.77 in Great Britain. Yet the Netherlands worker has won for himself a great reputation for careful finish, for diligence in work, adaptability to new techniques and ready acceptance of the results of research. The traditional Dutch commercial acumen, international trading connections and his understanding of the meaning of "service" complete the picture of the successful industrialization of Holland.

	Holland	*France*	*England*	*Germany*	*U.S.A.*
hourly wages, average skilled / unskilled labor, in U.S.$	0.48	0.64	0.77	0.59	
number of hours worked per week	49.5	45.4	46	48	40.6
exports on a per capita base, 1956 in U.S.$	265	106	173	139	114
expectation of life at birth, in years	71	64	68	65	65
density of population per km²	363	79	210	206	21
average hourly wage incl. social charges, in U.S.$	0.60	0.89	0.84	0.74	

The Netherlands	*1899*	*1952*	*1957*
industrial workers	647,000	1,565,000	1,780,000
metal industry	86,000	430,000	509,000
in building industry	147,000	256,000	324,000
in agriculture	572,000	519,000	499,000
total working population	1,924,000	3,900,000	4,200,000
total population	5,100,000	10,400,000	10,900,000

Holland Electric

An electro-technical manufacturers' and contractors' group

There is a certain difference between the mentality and outlook of the industrialist who, within the protecting walls of his factory and with calculable risks, manufactures a machine or other article, and those of the entrepreneur who, taking the risks of weather and wind in God's free nature, send out his ships, sinks mine-shafts or bores for oil. For the industrialist it is sometimes possible to make calculations as to whether a certain spare part will cost half a cent more or less: but the calculations of e.g. a ship-owner may be completely upset when a ship, that is costing $2,500 a day to run, is compelled to remain at anchor or outside port for three, five, or twelve days by, say any unforeseen stagnation or overcrowding in an overseas harbor. Again, he who drills for oil, or prospects for gold, is even more at the mercy of the whims of fortune. No matter how much those in oil, shipping or mining may try to put their economic activities on a calculable basis, there is, and will always be, a fundamental difference between risks taken by the industrialists whose activities are at home and those of the man searching for opportunities far from home.

As is well known, Dutch industry originated in close relationship with trade and shipping. It is probable that this historic affinity is the main reason for the special relationship that exists between the Netherlands industrial world and the oil industry.

In Holland the industrialist never had the chance to become an isolated aloof laboratory technician. In this low country, science and industry evolved in the constant awareness of the futility of man's efforts as compared to the grandeur of nature, the Dutchman's inborn knowledge that he must be efficient in order to survive at all.

The first principle of the Netherlands industry which developed largely in the last decades of the 19th century, about the same time as that in the United States and Germany, was to supply a good product. This same principle is particularly discernible in the Dutch electro-technical industry which also arose in the same period. In other countries large electro-technical industries were beginning to arise around 1880, largely because there already existed a large potential market. One of the founders of the Dutch electro-technical industry, Willem Smit, on the other hand, started in a little village on one of the islands of South Holland with the construction and manufacture of dynamos to supply electric light to ships owned by his family. His enterprise speedily grew, and before the end of the 19th century dynamos from Slikkerveer had found their way into the shipping world and to municipal power plants.

At the beginning of the 20th century, another electrical enterprise was established in the Netherlands: "Heemaf" began the manufacture of electric motors and associated equipment.

In those first decades of the present century, which brought to the Netherlands an unprecedented expansion in the generation and use of electricity, the number of enterprises engaged in the manufacture of electrical equipment and machines increased with great rapidity. "Hazemeyer" started in 1907 with the production of switchgear for low voltages. In 1915 the firm of "N.V. Coq" began production of high voltage switching equipment. Then in 1911 and 1913 two factories were started each making a single specialty: the "Electro Motorenfabriek Dordt" for the manufacture of small motors, and the "Willem Smit & Co's Transformatorenfabriek" at Nijmegen for the manufacture of power transformers.

In the same years two Dutch factories were established for the manufacture of wire and cables: the "Hollandse Draad and Kabelfabriek" which specialized in the making of rubber-insulated cables, and the "Nederlandse Kabelfabriek" which started the manufacture of paper-insulated cables.

These eight electro-technical enterprises, cooperated with "Holland Power," a contractors' group, taking care of the complete installation of their equipment.

After the Second World War, with an eye on the export market, cooperation between these firms was given legal substance in the form of "C.V. Holland Electric Industry Export," whose combined knowledge and experience has all the qualifications of a world industry.

Smit/Slikkerveer

The whole history of Smit Slikkerveer demonstrates how this firm has continuously aimed at specialization: they always manufactured special motors, generators and combinations which best met the needs specified by certain customers or certain branches of industry. From this policy there have originated the large generators for overseas installations, traction motors, and winch installations for ships, all of which have made the name Smit Slikkerveer known around the world. On this basis, too, the company has specialized in the manufacture of complete power installations, such as for cutter suction dredgers, installations that are always "special" and for which members of the flourishing Netherlands dredger-making industry are ready buyers. In more recent times the policy has taken another turn in the form of the production of equipment particularly designed for the oil industry, including a number of generators for diesel and turbo drive in refineries and tankers, motors for refineries and for pumping and compressor stations, complete transmission sets for diesel-electric ships, cranes and locomotives. Of this latter type of equipment, the

Diesel-electric drilling rig under construction at Smit Slikkerveer.

new diesel-electric rotary rig for the Nederlandse Aardolie Maatschappij (Netherlands Petroleum Company) is a striking example.

This rig is an adaptation of the "Ideal 55," powered by three Paxman diesels of 400 h.p. at 12-1500 rpm, and is intended as a prototype for acquiring experience. The layout, moreover, is novel in the field of rotary drilling. Instead of an individual Ward-Leonard system for each principal motor, all DC generators and motor are switched in series in one single circuit; this is called the constant current system. Motor speeds are regulated by field control obtained by amplidynes; this influences the voltage drop in the circuit across the armatures which is taken care of by automatic voltage control of the generators.

Load equalizing as well as starting procedures on the generator sets are fully automatic. One of the great advantages is the availability of all installed diesel power at both mud pumps and the drawworks independently without any manual switching being required, thus approaching the ideal as regards ease of operation. Other features are electrical limitation of torque (cable pull) for making the rig as safe as possible, whilst specially developed extra rugged switches cut generator and motor armatures out of circuit when not in use. The switching is also automatic after zeroing the field for stopping any motor, a time relay operating the switch. All motors are so robust that they can take at least a five minute stall.

Three diesel-driven generators are connected in a series system with the five driving motors for the drawworks and the pumps. The power-house is situated 100 feet from well center, thus giving much free area around the rig itself, as well as increasing safety. Additional technical details are as follows:

Surrounding the rig at suitable places are the drive groups for the drawworks, the main mud pump and the auxiliary mud pump. The generators and motors with their control panels are connected by means of flexible power and control cables. These cables are laid over the ground and are provided with suitable overpasses for trucks and other traffic. A special feature is the cable connection, designed for quick assembly and removal of the rig. On the drilling platform is placed a control desk containing all electric and mechanical controls for the pumps, the drawworks, and the rotary table, with the exception that the starting equipment for the generating units is provided on the units themselves.

The generating units consist of a driving diesel engine coupled to a generator, mounted together with a control panel on a a common skid. On top of the generator is a belt-driven amplidyne for the excitation. Each generator with its belt-driven amplidyne and control panel acts as a constant-current power source. To ensure equal load distribution for all generating units in circuit a special equalizing circuit is added.

The value of the constant current in the main circuit is thus maintained at any predetermined value which is 1000 A under normal conditions.

Generators not in operation are bypassed by the special two-way electromagnetic switch already mentioned. This switch is automatically operated to cut the generator armature in the circuit when starting the diesel engine and to cut it out when the diesel engine is stopped. Hence no current flows through the generator armature when the unit stands still. This being achieved without the necessity of any switching by the operator.

On the other hand, when the generators are rotating there is always a current flowing through the armature, thus ensuring good running of the brushes and low wear of brushes and commutator. The generators are of the self-ventilated two-bearing type with all windings insulated with Class B materials.

The identical electric motors are of the enclosed forced ventilated type for which a separately driven cooling fan is added. To get a quick acting control of the motors, the excitation is taken from a motor-driven amplidyne. Both fan motor and amplidyne motor are supplied from a separate A.C. source, which may be either an auxiliary diesel-driven generator or an outside supply, according to local circumstances.

In the rig just described the five motors are all of 400 hp operating at 1,000 rpm and at a voltage of 340 V. These motors are arranged as follows:

Two motors mounted with the two control panels on a common skid to drive the drawworks.

Two motors identically mounted as for the drawworks drive to drive the slush pump.

One motor mounted with its control panel on a common skid to drive the auxiliary slush pump.

The chain transmission from the motor-driven shaft to the pump or drawworks is oil lubricated.

Each control panel contains the motor-driven amplidyne and the automatically operated switch for connecting and disconnecting the motor. There are three explosion-proof panels containing a speed regulator as well as all necessary control and protection devices. As long as the generator controls are able to maintain the desired value of the current in the power circuit, the amplidyne controls of the motors in combination with the speed regulators provide for a smooth and almost continuous speed control, the only control about which the oil driller has to worry.

The torque-speed characteristics of the motor can be chosen to comply with the maximum torque capacities of the drawworks at its three gears.

In order to use as much as possible of a commercial drawworks (the Ideal 55 of the National Supply Company, delivered by Oweco), a method of operation has been adopted which does not, perhaps, do full justice to the flexibility of the electric drive. This, however, may be of a rather academic nature, as the fact that the motors are left running improves the hoisting performance because of the kinetic energy of the armatures. When it is necessary to reverse the drawworks motors for lowering the drill-pipe or to obtain reverse rotation of the rotary table, the operator puts the speed regulator in the position for reverse control. This can only be done with the speed regulator in the "off" position and by pulling out the hand wheel.

To obtain transport on normal trailers, all parts of the electrical driving equipment are constructed within certain dimensions and weight. The transportable parts are:

1. The generating units, each consisting of the diesel engine with radiator and a control panel on a common skid; total weight about 12,000 kg (25,300 lb).
2. The drawworks drive consisting of the two driving motors with the transmission and two control panels on a common skid; total weight about 11,000 kg (24,100 lb).
3. The main mud pump drive, identical with the drawworks drive.
4. The drive for the auxiliary mud pump consisting of one driving motor with its transmission and one control panel on a common skid; total weight 6,000 kg (13,200 lb).
5. The cables with a total weight of about 3,000 kg (6,600 lb).

In some ways the rig is a compromise. The inclusion of a main drawworks clutch may seem anomalous for an electric drive, but it has served well and allows the armature to retain its momentum, if desired, for rapid hoisting. Equally, the three speeds can be reduced to two, particularly if shaft drive in place of chain drive were wanted, which would seriously limit the motor speeds.

The system, called "Smitring" in this special form, is admirably suited for drilling barges and platforms by reason of the compact generator sets, the complete liberty of spatial distribution, and the very practical cable connections which allow for instantaneous coupling and uncoupling.

Willem Smit & Co's Transformer Factory

If ever one type of electrical equipment has grown in direct proportion to the development of the world electricity supply,

this has certainly been the case with transformers. After the eye-opening electricity exhibition in Frankfurt in 1891 had demonstrated that the future lay with alternating current, the distribution of electric energy developed at a great speed. In 1913 Willem Smit & Co's transformer factory was built. At that time 1250 kVA was the maximum capacity of any transformer. Today this factory is constructing transformer groups with a capacity up to 300,000 kVA for 380,000 V.

Transformer construction requires specially insulated copper wire, and in a short time the Smit factory became a specialist in the manufacture of this type of wire. Then, keeping in step with the time, the manufacture of welding transformers resulted in a separate factory being constructed for the making of welding electrodes and coating materials. Moreover, in Willem Smit's laboratories, welding techniques were developed that now take an important place in the company's production program. Finally, the fact that special transformers were needed for electric furnaces led to the company manufacturing electric furnaces themselves.

Through this rapid development and specialized production, this large Dutch transformer factory has become a supplier of the world market, especially that of the oil industry. Transformers for refineries, special heating elements for drilling units in the Far East and the Near East, and electrodes in various forms for the welding of stainless steel, chromium and molybdenum steel for pipelines, are now among the products supplied to the oil industry by Smit's Transformer Factory in Holland.

Electric motor Factory Drodt

When the Electromotorenfabriek Dordt was established, it was the only factory in the Netherlands using go no-go gauges for its products. This young industry emerged from an idea in the mind of Smit Slikkerveer for whom the first governing principle was "Quality above all." And this principle still pervades the whole production of the Dordt electric motor factory.

At the start, it was intended to undertake serial production of motors; at first small motors only, and later larger ones. Then there came the separation of the serial work and the manufacture of special products, so that now production takes place in two different factories, one for the manufacture of special large motors and the other for the series production of standard motors up to about 10 hp and in which mechanization has been expanded as much as possible.

At present the bulk of activitiy is centered on the manufacture of special motors (commutator motors up to even 1,000 hp) alternators and other special types of rotating machines and as already mentioned, high frequency motors up to 12 kV, often with direct switchgear. In this production adjustable induction motors soon played an important role: induction motors in many special designs, one of which is of the closed explosion proof type.

The experience gained in the supply of large numbers of these motors to the Dutch coal mines and then to the oil companies, have given E.M.F. Dordt a close acquaintance of all the requirements for this type of motor in all sections of the oil industry; motors for refineries, motors for the oil-fields, motors for tankers. And in all of them is to be found that quality and durability which has always been the hallmark of this typical Dutch manufacturing firm.

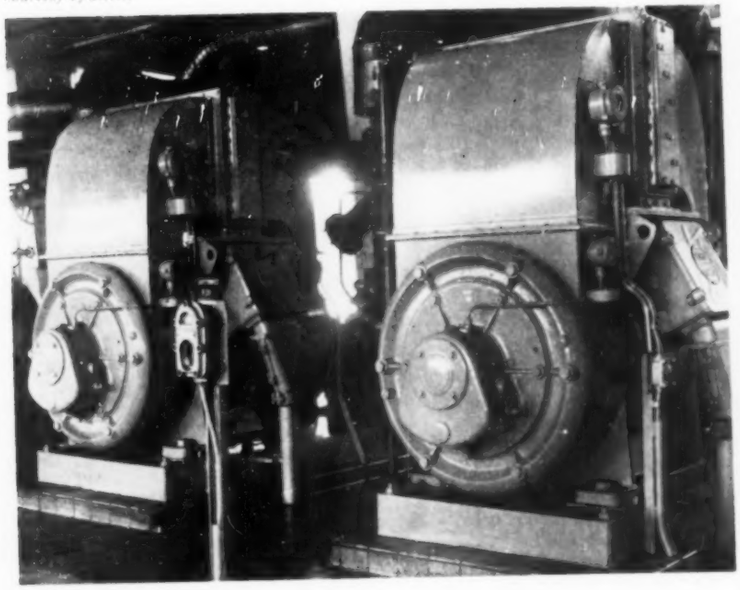
Heemaf

Even before the electricity supply in the Netherlands had really begun to expand and at the time when the potentialities of electric energy in industry were only faintly seen, Heemaf at Hengelo owned and operated a few small plants that supplied electric power and light to the community. Soon it began to make and sell electrical control equipment and switchgear, and in the First World War, it started the manufacture of motors, a production which leaped ahead after 1918 largely through the invention of the double squirrel-cage motor and generator in 1921. This invention gave a tremendous boost to the production of electrical machinery which before long became Heemaf's major line.

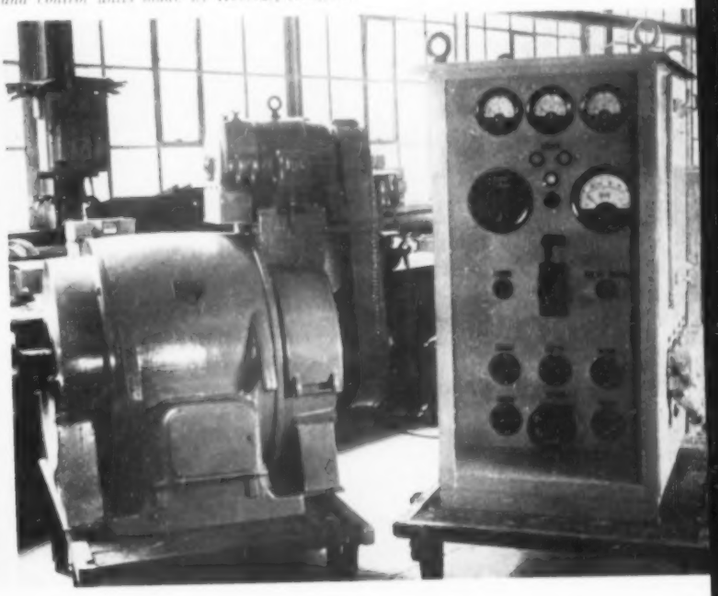
The motors and generators have become larger and larger and Heemaf manufacture has grown with the development of the electricity supply, its output now including not only motors and generators but also special switchgear and, in the past 20 years, also telephone equipment.

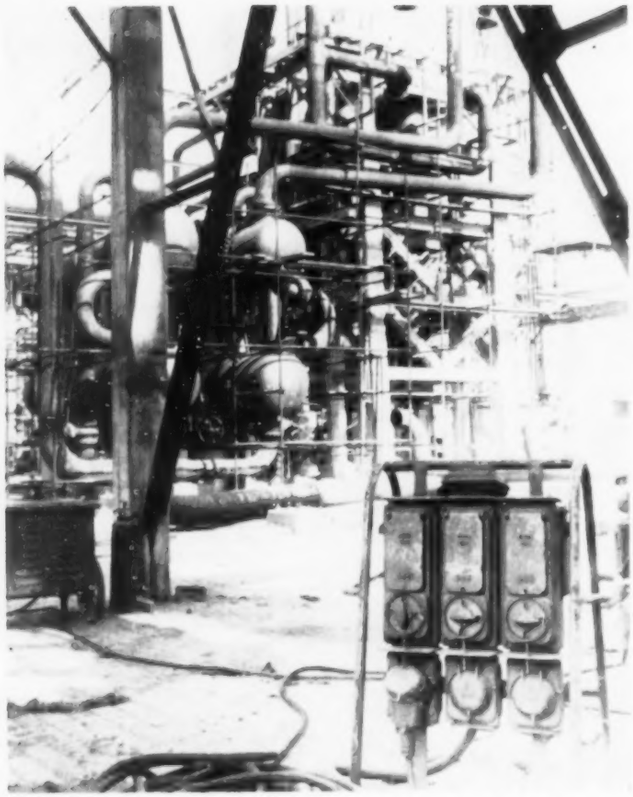
For the oil industry Heemaf has supplied many three-phase A.C. generators, either of the standard type or self-regulating, complete with specially designed portable switching and control units (see cut). The electric motors supplied range from oil well pump motors, motors for pipeline pumps and non-

Totally enclosed A.C. induction motors, (output: 400 hp—3000 rpm—3000 Volts— 50 c/s) provided with watercooler in the closed air circuit, made by Electromotor Factory Dordt. By courtesy of Shell.



Three-phase AC. generators with specially designed portable switch and control units made by Heemaf, Hengelo.





Transportable switchboard for electric welding equipment, made by Hazemeyer.

Airbreak contactor starter for well-pumping unit motors, made by Hazemeyer.

sparking motors for refineries to the fractional horse power motors for Tokheim Gasoline pumps. Heemaf generators and motors are in use in about 50 tankers, and many an oil company crane is fitted with Heemaf electrical equipment.

Hazemeyer N.V.

The need for "fool-proof" electric equipment, especially in switchboard apparatus has in the course of the years developed an important industry, namely switchboard and isolation equipment. As electric power increased its role in industry, the more each power failure represented a serious economic loss, and the more necessary it became to construct switchboard apparatus that would reduce such defects to a minimum.

As early as 1907 F. Hazemeyer realized the importance of switchboard apparatus for the growing electrical power industry and set about investigating the best techniques and how to put his ideas into practice. For 50 years now the firm of Hazemeyer N.V. has been specializing in the manufacture of protection switch equipment for low and high voltages, continuously improving it in the light of experience and electrical research.

This firm has grown into one of the world's largest and most reputed specialists in this field, and it now has factories not only in the Netherlands but also in Belgium, France, the Argentine, Great Britain, Spain and India, where Hazemeyer metal-clad totally enclosed switchgear is made.

For about 30 years the oil industry has been one of its most important customers. A typical oil industry product is the wellpump starter, in which the practical experience of the oil industry and the knowledge and know-how of this specialized factory are incorporated. A wellpump starter of 50 hp can be erected and connected within one hour by one man. The starter, moreover, is fully vermin proof, tropical proof, and even fool proof. The inner cover can be opened only by means of a special socket wrench when the circuit breaker and the selector switch are both switched off.

This special switchgear, however, is only one of a long list of switchgear equipment, ranging from switches for welding machines to switches for temporary lighting installations and to low tension unit type switchboards, which are a typical Hazemeyer speciality. Also a low tension cubicle-type switchgear up to 2,000 amps is part of the Hazemeyer program.

N.V. Coq

Another manufacturer of electric switchgear in the Holland Electric Group is "N.V. Coq," which for more than 40 years has been a large supplier of high frequency gear, including many products of a special type and design based on the firm's own inventions and developments.

For example, at an early date, this firm came to the conclusion that the principle of the cylindrical conductor surrounded by a concentric earthed sheath was the best approach technically to the problems of high-frequency equipment. This was followed by the functional separation of contact-making and driving elements. Also all switchgear made by Coq features the possibility of taking out or adding switching components while the permanent part of the switchboard installation remains "live."

On the basis of these three principles, the firm is manufacturing switch systems for voltages ranging from 2,000 to 220,000 V. Switchboards for pumping installations in refineries and for petrochemical installations in Indonesia, in Venezuela, in the Argentine and in Holland, originate from this factory. Every Coq product is enclosed in an hermetically sealed housing so that it can be used in the tropics or in any climate where the atmosphere contains salt or a high degree of humidity; it is also made in the smallest possible dimensions but with the largest possible operational reliability and the highest factor of safety.

Hollandse Draad- en Kabelfabriek Nederlandse Kabelfabriek

The connections between motors, generators, transformers and switchgear, products which the Netherlands electro-technical industry makes in such great variety, are made by an equally large variety of insulated cables.

Also in this field the Dutch industry has earned an enviable name. Holland was one of the first industrial countries, to lay down standards (in 1917) for the design construction and testing of wires and cables. At that

time Dutch enterprises making these products were still rather young: the "Hollandse Draad- en Kabelfabriek" dates from 1910 and the "Nederlandse Kabelfabriek" from 1914. But both factories had specialized from the start in a method of manufacture based on scientific knowledge and sound engineering; today more than ever, chemical, electrotechnical and metallurgical research play a fundamental role.

For many years these two factories operated separately but in cooperation with each other. While the former concentrated only on the manufacture of rubber cables the latter made exclusively paper insulated cables.

After World War II, in addition to the classical insulating and protective materials, thermoplastic synthetic materials have been increasingly employed. The Hollandse Draad- en Kabelfabriek has particularly specialized in working with these plastics, including the manufacture of products outside the wire and cable field. It is now one of the largest plastics fabricators in the Netherlands.

Because of the identity of their interests and work, the two concerns recently merged into one, so that at the present time one combined and concentrated industry is serving as supplier of every imaginable type of cable and wire. There is, moreover, a high frequency laboratory where cables and accessories for voltages up to 1,400 kV can be tested at temperatures of —10 C to 110 C.

This is only a glimpse of part of the work of one of the largest and best-equipped laboratories of its kind in Europe.

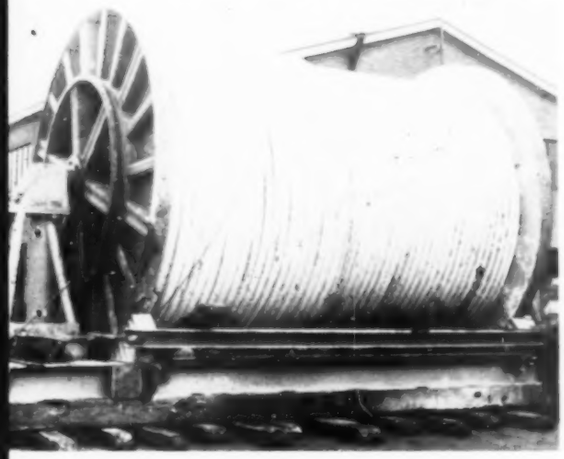
For its field work the oil industry needs many kinds of cable. These must be safe, reliable, proof against damage through rough handling, have great mechanical strength and be resistant to corrosion. Such cables are made by this section of the Holland Electric Group. The manufacturing program includes multicore power cables with protective sheathings of lead, steel wire armoring and plastic jackets; cables for underwater installations with Drakatilene (polyethylene) insulation and an outer covering of Drakavinyl (polyvinylchloride); heavy duty trailing cables insulated with butyl rubber and protected with a neoprene jacket; drilling well cables with a rubber insulation covered with a nylon sheath against ageing and wear; telephone cables with Drakatilene insulation and an outer jacket of Drakavinyl; and cables with an insulation of glassyard.

The Hollandse Draad- en Kabelfabriek has designed, in cooperation with Hazemeyer, one of his partners in Holland Electric, a special universal system for mobile electric lighting installations running from a main distribution box by means of several cable reels with built-in sockets and a set of lighting units. These Draka cables are protected by a synthetic rubber (neoprene) jacket which is almost indestructible. For derrick lighting there is a special Drakaflex cable with branch sockets for rubber lampholders and a suspension lug.

The special technical skills and constructive inventiveness and the wide experience of Holland Electric in the special requirements of the oil industry, have produced results: the Holland Electric Group now employ 20,000 men, of whom 4,000 are in the installation sector.

The Group represents a powerful industrial potential in a field which is traditionally a Netherlands specialty.

The laying of an underground cable.



Lead sheathed underground cable insulated with vulcanized rubber; steel wire armoring over lead sheath and outer covering of a strong Drakavinyl jacket.

Philips — Eindhoven — Holland

174,000 employees sales and service facilities the world over.

Giants of industry are not born: they are bred, and the breeding, it would appear, is induced by giant markets. The possibility of distributing huge quantities of merchandise in a demanding home market seems a *sine qua non* for the successful growth of a very large industrial enterprise. When established in a small country, the industry expands against odds. The relatively low saturation level of the market on its doorstep tends to force it into the much more complicated international commerce.

Since protective measures, national specifications and local preferences are established in every country, the industry which sets out to grow big in the international market finds many obstacles in its path. When not in a position to do marvels with its prices, it can reach its objectives mainly through progressive management, perseverance and quality production.

Philips, or N.V. Philips' Gloeilampenfabrieken, to give it its tongue-twisting Dutch name, is an example of such an industry, set up in a small market, which has grown to giant dimensions. Established in 1891 in an abandoned buckskin works in the village of Eindhoven, as a "Steam factory for the manufacture of incandescent lamps," it is now a world enterprise, organized in the manner of an industrial federation. National groups, each with a very considerable degree of independence, operate in more than 50 countries. In most of these countries are local manufacturing facilities. Nearly all other countries are served by competent agents.

Planned expansion

From the original product—the incandescent electric lamp—has risen a manufacturing program so diverse in scope as to defy the imagination. Such seemingly unconnected products as welding electrodes and weed killers, air liquefiers and amplifiers, X-ray spectrographs and extensometers, transistors and telecommunication equipment, cyclotrons and cinema projectors—to mention only a few—may all be regarded as the daughters of the unprepossessing lamp.

Philips people take pride in the fact that there is system in this diversity. "One thing simply led to another" is the saying, in which the word "simply" has, of course, to be translated as commercial alertness and intense scientific research.

Specifically it is the Philips Research laboratory, manned by several thousand scientists, which has always been a driving force. To trace in all details the family tree of Philips products would require more space than is afforded by this entire special issue of WORLD PETROLEUM. Some indication, however, can be given in a few words to explain the development of one or two product lines and thus give an impression of the historical growth of this enterprise.

From the manufacture of lamps, it was a logical step to radio tubes and from there to radio receivers. Continuity in this direction has led to the point where Philips markets a full range of all kinds of radio and TV equipment, including large screen color TV projection units. It is worthy of mention that each and every component of these is made in Philips factories.

For testing purposes on its own assembly lines Philips chose to make its own measuring equipments. Later these were marketed, as were the wide variety of other electronic research and control instruments which followed in their wake.

Radio cabin on board of the oil tanker "Isara."

Experiments to test the efficiency of ultraviolet lamps included the measurement of the amount of vitamin D generated in skin fats. Such large amounts of vitamin D were produced in the irradiation of ergosterol that this vitamin was soon marketed as a side line. Research into the composition and the chemical structure of this vitamin led to its synthesis in the laboratory and today Philips still has the world's first and largest vitamin D Plant. Philips also manufactures all kinds of other vitamins, as well as an impressive range of other pharmaceutical, veterinary and agro-biological chemicals including weed killers and radioactive isotopes for industrial and medical applications.

The guiding philosophy that the existence of a large industry cannot be made dependent on supplies of vital accessories and materials by third parties is the reason why ample "horizontal" manufacturing groups have been set up. Philips operates its own paper mill, which at this moment is the biggest corrugated board and packing paper plant on the continent of Europe. The huge mechanical engineering department is, for experts, a sight to behold—as are the glass, ceramic and rare gas, wire and plastics factories.

The upshot of all this planned expansion is a manufacturing program which fills many volumes.

The present situation

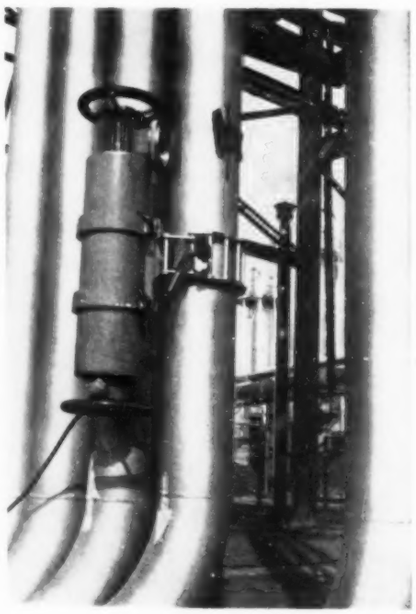
Without going into a host of unnecessary technical detail, a limited selection of products may be mentioned to illustrate how Philips does indeed operate in a broad area:

The original incandescent electric lamp is still going strong, and today some 40,000 different types are being made for every purpose under the moon.

Gas discharge lamps, fluorescent lamps and a number of special types for laboratory use have since been added. The fittings for many of these lamps are also supplied. Lighting advisory departments work out complete ornamental or utilitarian illuminations, outdoor as well as indoor.

Philips manufactures and markets through a worldwide network of distributors a complete range of electron tubes and semi-conductors. This range varies from the tiniest transistor to giant transmitting tubes for broadcasting and industry; from super-sensitive radiation detection tubes to heavy duty, steel-jacketed ignitrons; from tiny phototubes to 300 kV X-ray tubes; from television camera tubes to magnetrons; from mass-produced receiving tubes and picture tubes

Industrial X-ray equipment for the non-destructive testing of pipelines.



View of one of the Philips factory areas at ***Eindhoven.***

for radio and television to the robust Special Quality tubes for the most exacting applications.

Whatever the electronic device, there is always a Philips tube or semiconductor fitting it to perfection.

Philips radio and television sets, gramophones and records, dryshavers and domestic appliances—all these are bread and butter lines, to be found in homes, studios and offices the world over. Intercommunication systems, public address equipment and cinema projectors are also in wide use.

The primary aim of telecommunications is to bridge distance. Philips manufactures a wide range of telephone and telegraph equipment, radio and TV transmitters and radar; complicated equipment, incorporating novel developments such as automatic fault correction, high speed selectors and magnetic memories. Communication equipment of many types are installed on many oil fields and refineries.

In laboratories and manufacturing plants, a large number of quantities—humidity, temperature, acidity, strain, pressure, conductivity, vibration, flow and weight—must constantly be measured, recorded and controlled. Philips supplies the equipment for these purposes.

Welding apparatus and electrodes for general and special uses are important to the oil industry. Philips markets many types of electrodes for welding steels—mild steel, low-alloy, creep resistant and stainless steel—and CO_2 automatic welding machines and stud welding equipment.

"Scientific equipment" is the loosely descriptive name by which Philips codes such instruments as X-ray diffraction and spectographic units, industrial X-ray equipment, electron microscopes, equipment for measuring radio active radiations, impulse and high-voltage DC generators and installations for the acceleration of elementary particles. Also under this head is a small machine with which, in one step, air is cooled to liquefaction. When this is fed into an additional unit, pure liquid nitrogen can be tapped off.

Although manufacturing only medical X-ray equipment for diagnostics and therapy and short-wave therapy units, Philips is equipped to undertake the installation of complete hospitals and of mobile units; wide experience has been gained in tropical countries.

Pharmaceutical specialities include vitamins, vaccines, insulin, liver preparations and some less ethical—although very practical—weed and insect killers. Also available are radioactive isotopes such as are used to check the flow in pipelines.

Petroleum and Electronics

This diversity of products shows that few individuals, groups or organizations, whatever their sphere of activity, can claim to be in a situation where Philips products are not being used. In electrified areas, homes have lamps, radios and domestic appliances. Factories, laboratories, ships, aircraft use electric and electronic devices and so also do offices, theaters, highways and shunting yards.

The petroleum industry, which comprises activities of every kind and description, has always welcomed modern means to greater efficiency. It is hardly surprising therefore, that there are innumerable points of contact with an industry such as Philips. Recent developments in data recording and computing, in telecommunication and isotope tracing, in arc welding and in the measurement and control of many phenomena are the immediate fruits of modern electronics. Remote control and automation would be hollow phrases without this science.

In the many intermediate stages between prospecting for oil and the use of the finished product by the consumer, the oil industry uses a vast array of mechanical, hydraulic, electric and electronic appliances. For the latter two the petroleum world may confidently turn to Philips

Diversity

An alphabetic random selection of Philips products demonstrates their diversity.
A. Arc welding equipment, and Amplifiers
B. Battery chargers, and Bi-metals
C. Cinema equipment, and Cyclotrons
D. Domestic appliances, and Dryshavers
E. Electron tubes, and Electrodes
F. Filtration equipment, and Ferrites
G. Gramophone records, and Glass
H. Hospital equipment, and Herbicides
I. Image intensifiers, and Isotopes
J. Jumbo valveholders, and Jack strips
K. Key switches, and Klystrons
L. Liquid air machines and Lamps
M. Magnetic Tape recorders, and Mobilophones
N. Nuclear instrumentation, and Neon tubes
O. "Oralix" X-ray units and Oscilliscopes
P. Pharmaceutical products, and Potentiometers
Q. Q-band ASMI radar, and Quartz crystals
R. Radiation monitoring equipment and Radio
S. Semiconductors, and Strain gauges
T. Telecommunication equipment, and Television
U. U.H.F. measuring equipment, and U.V. lamps
V. Variable transformers, and Vitamins
W. Welding equipment, and Wire
X. X-ray equipment, and Xenon gas
Yes and much more. But of this you can be sure: from Zero to infinity—Philips quality can be relied upon.

Floating equipment for off-shore drilling comes from

I. H. C. Holland

Along the Dutch waterways many industries have risen among which shipyards have always occupied a prominent place. Here the ships are built that sail from Holland over the seven seas or along the world's rivers and canals. These yards also build the craft that enable other ships to ply their cargo. Dredgers of every type, tugs, tankers, utility vessels of every description and size; such auxiliary vessels have become a Dutch specialty.

A combination of six Netherlands shipyards most prominent in this field, I.H.C. Holland, is one of a number of cooperative industrial groups that have grown up in the Netherlands. I.H.C. Holland is a joint company, in which six of the oldest and most specialized shipyards have pooled their resources, each being responsible for every transaction carried out by the group. This has led to an intensive and fertile cooperation between the partners.

Artist's impression of new drilling pontoon.

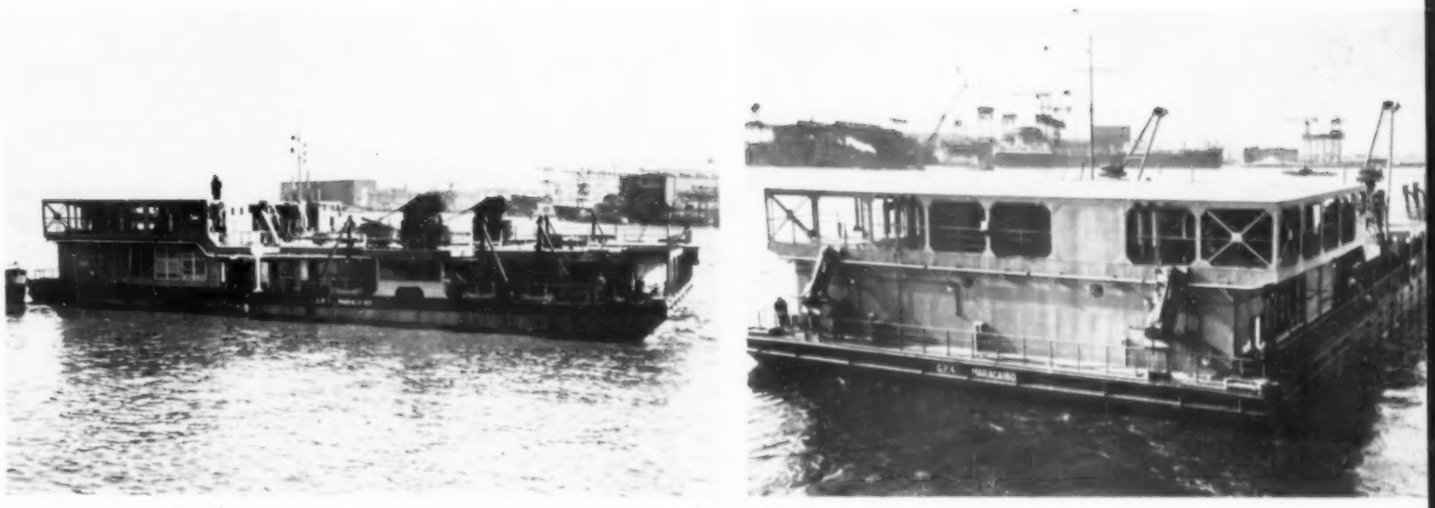
In the matter of building bucket and suction dredgers, floating cranes, utility craft, the technical ability and experience of six specialists are now at the disposal of every customer. Their experience has been gained through the years in projects all over the world, in Africa, in America, in Asia and in Europe. The variety is astounding and has given I.H.C. Holland a special reputation in the field of utility vessels. This was earned by the capacity and facilities of the group which include not less than 27 slipways and more than 6,000 men. During the past ten years *hundreds* of suction and bucket dredgers, mineral dredgers, floating cranes, rock-breakers, tugs and other units have been built.

I.H.C. Holland, for instance, built the enormous tin dredgers being used for tin mining near Banka and Billiton in Indonesia; they supplied the dredgers and the conveyor-belt transporting equipment for the Rhone Valley canal in France between Donzère and Mondragon, the largest hydraulic project executed in Europe since the War.

They also built a fleet of dredgers for Pakistan, ferries for Turkey, tankers for Indonesia, cranes for Iraq. The complete list would run to many printed pages.

Now that off-shore oil drilling operations are becoming increasingly important the oil industry requires many new floating units for

A 1500-ton river tanker.



Service barge for Maracaibo.

work under the most different and often adverse conditions. It is small wonder that they put their problems to shipbuilders such as I.H.C. Holland with their wide experience in special vessels. These shipbuilders can really contribute original ideas in the design of floating equipment suitable for marine operations.

I.H.C. Holland, build under license hydrofoil vessels used by the oil industry. These strange fast ships, when travelling at speed, are supported on the immersed surface of the hydrofoils, the main hull being raised clear of the water, with a consequent substantial reduction of wavemaking and frictional resistance. It is certainly an unusual experience to travel in such a modern speedboat at nearly 50 miles an hour over and not through the water.

From its wide experience in building floating cranes, I.H.C. Holland designed a 400-ton unit mover for 24' and 30' drilling towers. The crane arm consists of two parts between which a whole drilling tower can be lifted at a hoisting rate of two feet a minute, the power being supplied by two diesel motors each of 120 hp.

I.H.C. Holland also built several service barges with complete power supply installation and workshops.

But, so far, the crowning achievement for the oil industry is I.H.C. Holland's new offshore mobile drilling unit. This equipment is of the elevating, self-supporting barge type for drilling oil wells about 17,000 feet deep in water depths of from 15 to 100 feet. The whole platform rests on eight legs, 200 feet long, which can be lowered by means of a patented jack system; the pontoon can be lifted up to about 50 feet above sea level.

On this pontoon there are tanks for oil, drinking water, salt water, crude oil and mud. On the main deck is the engine-room for the cooling apparatus and the CO_2 and minifire installations. In the pump room are the slush pumps, whilst the drilling floor is located at the front of the pontoon. A flight deck for helicopters is on the top of the deckhouse.

Another facility is a large crane with a lifting capacity of 75 tons. Living accommodation is provided for about 80 men. Two diesel generators of 550 KW DC and two of 300 KW AC supply the necessary current.

The name of I.H.C. Holland is a household word to those concerned with civil engineering, dredging and port operations all over the world. For anything that floats, works on the sea, pumps or drills, I.H.C. Holland can be trusted to come up with designs which guarantee reliability.

I.H.C. Holland
build for the
petroleum industry

- **marine drilling equipment**
- **service barges**
- **tankers and all other vessels**
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I.H.C. Holland
SHIPBUILDERS—ENGINEERS
2, Verlengde Tolweg
P.O. Box 6058
THE HAGUE

Hydrofoil boat at full speed.

Rotterdam Europort — Gateway to Europe

Within the past 100 years, and in a Europe sharply divided, Rotterdam has become the largest harbor on the Continent and the second largest in the entire world.

Located at the natured mouth of the River Rhine and the River Meuse, the two waterways along which the most important part of the stream of goods goes to and from the industrial area of Western Europe, Rotterdam has taken full advantage of its special position and conditions to grow into an outstanding maritime metropolis.

The development, moreover, becomes even more striking when it is seen that in Northwest Europe, along a coastal area not much longer than that between Boston and New York, five very large seaports have sprung up (Hamburg, Bremen, Amsterdam, Rotterdam and Antwerp) all striving to obtain as great a share as possible of the flow of goods to and from the European hinterland. The rivalry was the keener, too, as a result of differences of a politico-economic nature, stemming from the fact that the five ports lie in three different countries with different policies and outlooks.

In this stern competitive battle, which started with the rise of German industry in the Ruhr in the last part of the 19th century, there are several reasons why Rotterdam was able to gain its present position. The first of these is undoubtedly its location, for the Rhine, the mouth of which is governed by Rotterdam, is the great water highway from the densely-populated and highly-developed industrial areas of Germany to the open sea, the important economic areas of France and the strongly industrialized regions of Switzerland.

To this, however, must be added the fact that, especially in the past few decades, the Netherlands itself has rapidly increased its industrial potential, with a consequent rise in both imports and exports of which Rotterdam was able to take full advantage. There was also the special activity and experience of Rotterdam's harbor firms and traders who knew how to make the most of the economic possibilities the harbor offered, and who were able to rise again, Phoenix-like, to a virtually complete renewal and reconstruction, from the devastation of the Second World War.

The combination of all these circumstances has resulted in a harbor growth at a phenomenal speed: the number of ships entering Rotterdam, increased from 15,000 in 1938 to 22,000 in 1958, while the actual tonnage was doubled in this period.

During that same period the traffic in general cargo rose from 7,800,000 tons to 11,000,000, whilst in bulk transport the coal handled rose from 11,000,000 to 15,000,000 tons and that of petroleum from less than 3,000,000 to 32,000,000 tons.

Parallel to this great increase in freight traffic, the docks of Rotterdam have been greatly improved and expanded, making the whole complex into one of the largest and most imposing in the world.

But the end of the expansion has by no means been reached. Indeed, the most important extension of all is in hand at the present moment. At the mouth of the River Rhine there will shortly be a large new harbor area constructed under the name Europort, especially designed and intended for the handling of the largest ore and coal vessels and mammoth oil tankers at a time when such provisions are of new significance and importance.

The present and future extensions of the Rotterdam Harbor area have been planned to cope with the expected growth of the stream of goods expected to result from the economic integration of Europe through the Common Market—an increased flow of raw materials and energy sources and a much enhanced industrial export.

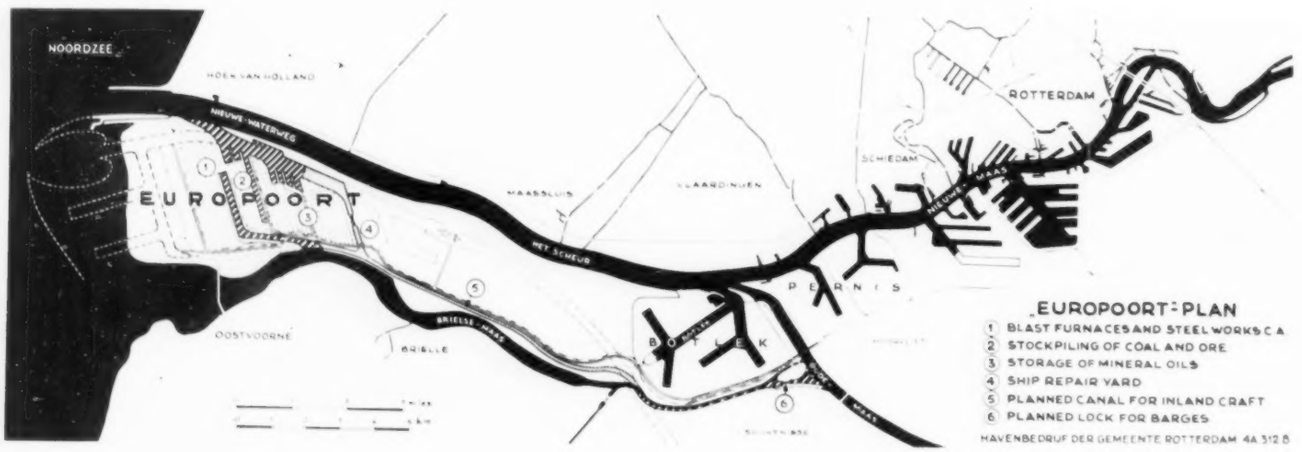
As far as the new Europort phase of Rotterdam's activities is concerned, and its economic basis, oil will almost certainly take first place. This is the consequence of two factors: on the one hand there will be an increase in total supply and transport of oil and on the other hand there will be a rapid growth in the size of the tankers. An ever-growing stream of oil will inevitably flow into Europe.

At the present time Rotterdam is handling over 30,000,000 tons of oil annually, whilst during the period 1965 to 1975 this figure is expected to increase to a minimum of 50,000,000 tons a year. This rise alone would necessitate still further expansion of Rotterdam Harbor, the oil area of which has been increasing by 75 acres a year in the past ten years.

The reconstruction and expansion need has also been greatly intensified by the growth in size of vessels carrying oil, although it is

PORT OF ROTTERDAM

Year	*1929*	*1938*	*1950*	*1958*
Number of Ocean-going Vessels Entered	12,739	15,360	12,883	21,956
Movement of Goods in Millions of Tons	36.6	40.2	28.9	70
Miscellaneous Cargo in Millions of Tons	7.6	7.8	6.8	11
Dry Bulk Goods in Millions of Tons	28	29	13	27
Petroleum in Million of Tons	1.07	2.9	9.02	32



View of part of the petroleum site at Rotterdam harbor.

fortunate that the unloading time of the tankers is not lengthened in proportion to the increase in the capacity of the vessel. (A 30,000-ton tanker, for example, now has an average unloading speed of 1,500 tons hourly, whilst for a 50,000-ton vessel this rate can be raised to from 2,000 to 2,500 tons an hour). This means that the quay space, which is effectively the harbor space, to be used by the oil industry must be adequate to accommodate future tankers no matter how large they grow.

Recently the problem of supplying crude oil to Europe has been tackled in a new way by the pipeline system at present under construction and designed for early operation. This will feed large quantities of oil to refineries in the German industrial area from the three great seaports of Marseilles on the Mediterranean, Rotterdam on the North Sea coast and Wilhelmshaven in Northern Germany. In this respect Rotterdam is again in a specially favored position because the pipeline now being constructed to the Ruhr area is the shortest of the three.

The tanker is under most circumstances still the cheapest method of oil transport. Middle East oil, therefore, will probably be taken to the Ruhr area more cheaply by sea to Rotterdam and then by pipeline than if it were dropped off at Marseilles and sent through the much longer pipeline, or by road, from there. There are, of course, inland waterways that are used, but the competitive position of a pipeline in this connection can be seen from the fact that a large Rhine tanker of 2,000 tons can transport about 70,000 tons of oil a year from Rotterdam to the Rhine refineries, which would mean a fleet of almost 300 of these vessels to supply the German industrial area with the 20,000,000 tons of oil envisaged for the future.

It is in view of this expected increase in oil supply and transport, as well as the need for handling greater quantities of coal and ore, that Rotterdam has reorganized its harbor area and made its great expansion plans for Europort. The plans are based, moreover, on a very detailed survey of industrial, economic and geographical considerations which must always be the foundation of such a project as a new world harbor.

It cannot be too strongly emphasized that this plan started from the certainty that the near future will bring not only an increase in the volume of goods to be handled for Europe through Rotterdam but also, and particularly, an increase in the average tonnage of ships. If the new harbor basins to accommodate the largest tankers should be constructed adjacent to, or even in the middle of, the existing harbor complex, this would mean an essential widening and deepening of the New Waterway, the channel leading from the North Sea into the main Rotterdam Harbor. It therefore seemed a more practical and economical plan to build a new harbor at the very North Sea mouth of this New Waterway in the form of a sea terminal which would be completely reserved for harbor activities which primarily relate to unloading, loading and otherwise handling bulk commodities on a large scale. And as a background to this special service, a large blast furnace and steelworks is to be built in the Europort.

Under this ambitious expansion plan Rotterdam seaport will comprise three large new harbor areas: Pernis, the Botlek region still under construction, and Europort on which work is now in full swing.

The Pernis area has developed remarkably in the course of the past few years into an industrial, but particularly an oil, region of the first order. In it are situated the refineries of the Royal Dutch Shell Group, producing 15,000,000 tons a year or 30,000 b/d from the largest installation of its kind in Europe, and the refineries of Esso and of Caltex. In total the output from the Pernis complex is 25,000,000 tons annually or 500,000 b/d. Here, too, has grown up, and is still growing, a very important petrochemical industry.

It gradually became clear in the past few years that the Pernis area would soon become too small to cope with the demands of the oil companies. Rotterdam therefore extended its harbor further westward and began to develop the Botlek area. Here, too, a new Esso refinery is being erected now. The petroleum storage industry, large new shipyards, storage for edible oils, and ore storage facilities for the expected supplies of Labrador ores are among the outstanding activities, side by side with the general transshipment of bulk goods and various industrial enterprises.

The harbor basins of the Botlek area, which are in direct connection with the New Waterway and thus with the North Sea, can accommodate vessels of up to 50,000 tons, which gives it very great potentialities, and will add tremendously to the value of Rotterdam. The vision of even larger vessels, especially tankers, which comes daily nearer to reality, and the widening need for greater supply and storage space for raw materials as a result of European economic integration and the general liberalization of trade, led Rotterdam to take what is perhaps the most momentous decision in its history: the decision to design and develop the new Europort.

On the area chosen neither Nature nor technical problems are being permitted to limit the practical possibilities of the plan. On an area of 3,800 acres the most modern harbor basins and quays are being constructed with adjoining storage sheds for huge quantities of coal and ore giving ready access to the jetties used by both ocean-going and inland ships.

In the first stages provision will be made for berthing and handling 70,000-ton ships, with over one third of the area reserved for the storage of oil for transport to Pernis and the Botlek refineries by pipeline, and to the pumping station for the trans-Europe pipeline. Here, too, will be the blast furnace and steelworks which will start with an annual production of about 300,000 tons of steel and then be expanded to a capacity of up to 3,000,000 tons a year later.

When oil tankers become even larger—up to 100,000 tons is envisaged—Europort will be extended on the west by the building of the harbor out into the sea to provide even greater and safer facilities for the largest ocean-going vessels.

From this brief review of the Port of Rotterdam, the second largest in the world, it can be seen that the authorities in charge of that maritime center are still striving for expansion and improvement. In a word, it seems certain that the great past of Rotterdam will be overshadowed by its great future, the result of the imaginative utilization of its natural position and its long experience.

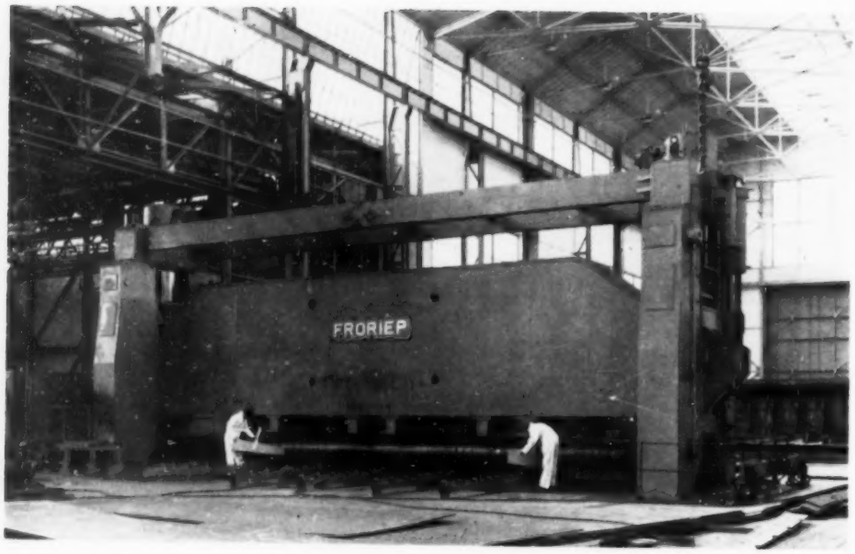


Plate bending for welded steel vessels

de Schelde

A modern shipyard . . .

The "Schelde" shipyard has built many tankers; a number of 32,000 tons motortankers are under construction.

Large all-welded cylindrical or conical shaped steel vessels involve much heavy plate bending.

A modern shipyard for the building of large tankers must be equipped with heavy duty machine tools for the bending of cylindrically shaped plates for the shell and for shaping the corrugated bulkhead plates.

The manufacture of steel vessels for oil refineries and heat exchangers for atomic powerplants can be done advantageously in a modern shipyard which has large welding shops at its disposal. Three aluminum alloy reactor heat exchangers and a pool-cooling heat exchanger for the Dutch 20-MW Test Reactor near Petten has been delivered by the Schelde Yard to ACF Industries Inc. For the preparation of the plates, however, a plate bender of much more power than that normally used in shipbuilding was necessary. For that reason "De Schelde" yard installed the biggest plate bending rolls in the world.

This machine, which was made by the Frotiep factory at Rheydt, Germany, has several special features.

It consists mainly of:

a. A heavy lower beam housed in a concrete foundation under ground level, carrying two rollers each of 480 mm diameter. These rollers have shaft drive transmission from one end.

b. A heavy upper beam carrying the upper roller of 520 mm diameter.

c. Two columns at each end connected by a steel structure at the top. The upper beam can be moved up and down hydraulically between these columns.

d. Electro-hydraulic equipment for moving the upper beam, consisting of two main rams on top of the columns giving a total compression force of 1,700 tons. In addition two secondary rams are fitted for raising the beam. Two high-pressure oil pumps driven by 25 hp electric motors serve the electro-hydraulic system.

e. A driving gear for the lower rollers consisting of a 250 hp electric motor and a two speed gear box.

Both lower rollers can be displaced sideways over a small distance for rounding the edges of the plates. This system is driven by a 20 hp motor.

The movement of the upper beam can be limited by means of a stop moving along an electrically vertical screw spindle. For this purpose there are two 10 hp motors. Each end can be moved separately so that the beam can be placed in an inclined position for bending conical shapes. This mechanical limiting system enables the beam to be set exactly to a required position and allows adjustment within fractions of a millimeter. Another very important feature is the design of the supporting rollers. The main rollers have three pairs of supporting rollers each. They are housed in a frame which can be moved mechanically and parallel to the rollers on wedge-shaped beds. Consequently each pair of supporting rollers moves vertically, the outer pairs less, however, than the center pair. This adjustment results in the main rollers being curved slightly. Theoretically a plate can thus be sent in two directions simultaneously, through the difference in bending radii. In practice, however, this system is particularly suited to the accurate cylindrical bending of plates. Each plate coming from the steel mills has unequal thicknesses in the center and at the edges.

Bending such a plate in a three roller bending machine tends to cause the edges of the plate to be curved. By adjusting the supporting rollers these edges can be straightened so that the finished plate is perfectly cylindrical.

For corrugating and flanging purposes special tools are available. A plate of 13 meters with a thickness of 22 mm can be flanged in one stroke under full load. All movements and positions are visible on dials on the control panel.

The machine is of all-welded construction. The total weight is about 330 tons. The concrete foundation has a length of 23 meters, a width of 6.4 meters and a depth below ground level of about 8 meters. It weighs about 600 tons.

The capacity for cold bending is given in the table.

Thickness of plate in mm

Width of plate in mm	*Steel 42 kg/mm²* R *1000 mm*	R *3500 mm*	*Steel 50 kg/mm²* R *1000 mm*	R *3500 mm*
1000	106	112	97	103
2000	72	76	66	70
3000	62	65	57	60
4000	55	58	50	53
5000-13000	49	52	45	48

N.V. KONINKLIJKE MAATSCHAPPIJ

„De Schelde"

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The Rotterdam Dockyard Company

(The initials R.D.M. stand for Rotterdamsche Droogdok Maatschappij)

Rotterdam, largest seaport in Europe and second largest in the world, is accustomed to anything and everything big.

When 60 years ago a booklet written by a leading Dutch engineer, drew attention to the fact that the shipbuilding and ship-repairing capacity in the Netherlands was insufficient, it was a group of Rotterdammers who took the initiative and established a large and modern dock company, which from that moment could cater to all needs.

In this way a ship repairing organization was started with two privately owned floating docks of 3,000 and 7,500 tons lifting capacity and technical equipment that made it one of the most up to date yards in Europe.

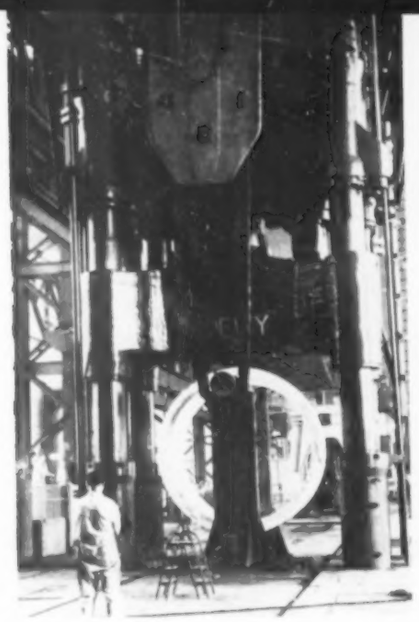
Soon afterwards, apart from ship repairing, the building of ships, engines and boilers was undertaken, and the first ship constructed on the slips was a freighter of 1,850 tons.

In the past half century The Rotterdam Dockyard Company has continued to develop side by side with the port of Rotterdam itself.

The favorable location of Rotterdam and the expansion of industry in the German hinterland and especially the enterprise and effort of its industries has made Rotterdam the largest and most important harbor in Europe.

The first two floating docks soon proved inadequate, and the capacity was steadily increased so that now 10 floating docks are available of which the latest additions are two docks with a lifting capacity of 52,000 tons and 54,000 tons which can accommodate supertankers up to 85,000 dwt.

After the first cargo ship a mighty fleet has emerged from the yard, freighters and tankers, cruisers, destroyers and submarines, ships for all purposes, culminating in the building of the largest passenger vessel of the Netherlands merchant marine, the NIEUW AMSTERDAM, which on every trip keeps the Netherlands flag flying high over New York harbor.



Forging a secondary gear wheel rim on the 6000 tons forging press. O.D. 12' 1", I.D. 10' 6", breadth 3' 0".

From the same slipway the flagship of the Holland-America Line, the ROTTERDAM, was recently launched and is now nearing completion.

Ships are getting larger and larger, and therefore the R.D.M., now building a series of 47,500-ton tankers which are the biggest the existing slip-ways can accommodate, has started the construction of a new slip-way.

This huge slip-way will be big enough to build tankers of 150,000 dwt.

The size and weight of their components have grown with the ships. The R.D.M. forging shops are equipped with hydraulic presses of 3,300 tons and 6,000 tons capacity and the necessary oil fired forging furnaces and gas-fired and electric heat treating furnaces. Ingots weighing up to 100 tons can be handled.

Modern and very large machine tools are available to machine all forgings produced by the yard for its own use or ordered by third parties. Apart from all kinds of components for diesel engines up to the largest crankshafts, complete turbine installations and water tube boilers are manufactured.

A specialty of the R.D.M., which originated from the production of marine boilers, is the manufacturing of heavy equipment for the oil industry. Heavy pressure vessels, with shells of 4" thickness or more, fractionating columns, reactor vessels and regenerators for catalyst cracking plants, heat exchangers, reboilers etc. are regularly produced in all kinds of steel and other material, according to the API-ASME code.

For stress-relieving a 16'6" x 16'6" x 49' furnace is available.

Hortonspheres for butane and propane storage are part of the manufacturing program.

With a view to the coming nuclear age and to increased capacity and to facilitate production of these heavy vessels a large and well-equipped engineering shop is being built.

After its completion the R.D.M. will be even better placed to produce any conceivable vessel that the oil industry might need.

28,250 Cu.ft. Spherical Propane Container I.D. 37'8.3/4", Wall Thickness 1.21/32", weight 130 tons. Assembled and completely welded in workshop.

Verolme's Shipbuilding Yards

From little acorns . . .

For seven years Prince Johan Maurits, Netherlands Governor of Brazil, served the Brazilian people. On his departure for home in 1644 the Brazilians literally carried him aboard the ship. His record still lives to the present day in the memory of that country. Johan Maurits represented Netherlands service to a foreign country at its best, whilst his political testament showed an insight centuries ahead of his time.

Nearly three hundred years later, another Netherlands Prince, accompanied by a Netherlands merchant and shipbuilder, went to Brazil. In the early days of February 1959 H.R.H. Prince Bernhard and the well known Dutch shipbuilder Cornelis Verolme stood on the coast of Brazil, and were officially received by the Brazilian authorities. Cornelis Verolme took to Brazil that country's first tanker, the "Presidente Juscelino," of 35,000 tons, built in the Netherlands. To Brazil he also took knowledge and experience of ship building which will be used in the new Brazilian shipyard to be erected there.

Deep in the Dutch waterland, where the mouths of the Rivers Rhine and Meuse intersect the flat countryside with many arms, and many miles away from the open sea, lies one of the many Dutch shipyards. It has been there for over a century, turning out first small wooden and then small steel ships on a small slipway with moderate equipment. In the early spring of 1954, this yard was taken over by Cornelis Verolme, and within a few years it was a fine modern slipway from which last year a 20,000-ton tanker was launched. It then took two days and two nights to tow the vessel, laden with 16,000 tons of water, under the four low bridges across the narrow rivers which had been expressly dredged for this journey, until it was finally tied up at the fitting wharf of the Nederland Installatiebedrijf. The "Tahama" was the first creation of the Verolme yards.

At the entrance to the Bay of Cobh in Southern Ireland, on the sailing route to Cork, four oil companies are building a great refinery. In front of Cobh, on Haulbowline Island, is the old dock of the former British naval base, whilst further along the way to Cork is the dockyard which is now being expanded by Verolme into a modern shipyard. The old naval dock can be enlarged to a capacity of 50,000 tons; the Cork Dockyard has a dock for ships of 16,000 tons; and Verolme can build new slipways for ships of 50,000 tons.

In this way, the Irish Republic, with the cooperation of the Netherlands will now obtain a modern yard for ship repair work.

Within a decade Cornelis Verolme has established a modern shipbuilding and ship repair enterprise.

Starting in 1947, after having been chief engineer of the oldest and largest Netherlands engineering works, he erected a small engineering workship in IJsselmonde, an area where Dutch shipbuilding had been carried out for almost two centuries. In the following ten years that small ship-fitting workshop has grown into a modern engineering works in which diesel engines, boilers, steam engines and turbines for ship propulsion are built.

The waters near the mouths of the Rhine and Meuse have long been the home of shipbuilding, but occasionally yards have had to close down because of their failure to make the fullest use of new techniques, new organizational methods and new inventions. In 1950 Verolme took over one of these old yards, and four years later acquired a second one in which, with traditional and sometimes outworn methods, small vessels were built. Within a few years both of these old yards had been completely modernized, and slipways for ships of 20,000 tons and 33,000 tons made it possible for Verolme to build modern tankers and freighters.

Orders from Finland, Persia, and Brazil poured in, orders, too, from the American and the Dutch oil industry, all executed on the new slips which sometimes had to grow in size simultaneously with the ships under construction.

Nor was that the whole story. At the same time Verolme was taking over the two old shipyards he also was laying the foundation for a completely new construction and repair shop in the new Rotterdam harbor area of Botlek. Here a start was made with the building of a 110,000-ton dock, and so progressive are the methods used by this enterprising Netherlander that while the new dock was still under construction the keel was laid in it of the 33,000-ton Brazilian tanker "Presidente Getuli." At present the dock contains the Brazilian aircraft carrier "Mina Gerias," which is to be completely renovated and modernized. When that is finished, a start will be made with the building of three 73,000-ton tankers for the Esso group.

"Nothing has meaning for man except insofar as it is directed towards the future. The past has meaning as a school for learning, but the practice of life must be directed entirely towards the future."

This principle, enunciated by one Ortega y Gasset, has been adopted as the principle of Verolme United Shipyards. Based on centuries of knowledge and experience of Dutch shipbuilders, this company has an enterprise and activity entirely directed towards the future. It is a shipbuilding firm based on certain vital factors: a location on the great petroleum harbor of Rotterdam, active cooperation with overseas countries where the development of industry and trade makes expansion of their own mercantile marine advisable, and the opening up of new economic perspectives.

In and around Rotterdam stand the shipyards, machine workshops and the docks of Verolme. In the Bay of Jacuacanga, between Rio de Janeiro and Sao Paulo and not very far from the new Brazilian steel industry, Verolme is building a new shipyard center with slipways for vessels of at least 10,000 tons, and probably much larger. And in Ireland the national marine and the international oil industry are being provided with modern shipbuilding and shiprepairing facilities.

Wherever in the world expansion makes new shipbuilding or repair possibilities desirable, Verolme can make Dutch experience available to serve the future.

Verolme's shipbuilding yards at Alblasserdam for ships up to 33000 tons.

Verolme's Machine Factory where ships are getting their upper structure.

J. C. Den Haan
Hercules Rope and Cable

Few countries in the world have retained their individual character through the centuries as has the Netherlands. What Holland is today it certainly owes to the fact that in former generations technical skill and handicrafts were highly regarded and diligently practiced. These characteristics, indeed, have remained in the Dutch, and are nowadays manifested in their manufacturing skill with the help of the most modern means.

One of Holland's most popular folk songs tells of the country's greatest seaman, Admiral Michiel de Ruyter of Holland's Golden Age, spending part of his time as a boy turning the wheel at the rope walk. This was perhaps natural, because for centuries the Netherlands, as a land of shipping and fishing, has also been a land of rope making. In all the large towns of the provinces of Holland, Frisland and Zeeland, the home ports of Dutch ships, large and small rope walks were to be found. In Amsterdam, the capital, where the United East Indies Company had its headquarters, there were the rope walks of the Admiralty, the authority which controlled and supervised the fleet. There, too, were the enormous buildings in which the Company's vast riggings were made and in which the beaten ropes were protected against deterioration by dipping in huge tar kettles. But also in the smallest towns of the Netherlands—truly a waterland—ships were built; and wherever shipbuilding was in progress ropes were made.

Up to the end of the 19th century the technique of making rope remained practically unchanged. But a start had been made with new methods, for even in 1895 the rope making firm of Den Haan, which had been established in 1600, began using steel wire in the so-called Hercules cable invented by that firm. It was not long before the age old rope making firm was transformed into a modern rope factory, called the "Staaldraadkabel en Herculestouwfabriek formerly J. D. den Haan."

Because the quality of the rope or cable is so important not only for the safety of the ship and its cargo but also for the lives of the crew, Dutch shipowners—like the majority of owners all over the world—have always insisted on ropes of the highest quality. This demand for perfection is likewise a hallmark of the steel ropes and cables made by the firm of Den Haan, achieved by the marriage of long experience and the most up to date technical methods. Hundreds of different varieties of wire form the basis of the strands of which the hawsers are made; ropes and cables which not only serve shipping for towing and rigging, hoisting and mooring, but also for lifting bridges, hoisting lifts, raising the doors of enormous locks, all kinds of harbor work, draining and dredging, and mine construction all over the world. And, of course, cables for many different uses in the oil industry, for rigs, etc.

Traditional hemp ropes and hawsers are nowadays still protected by tarring from the effects of wind and weather, whilst the ultra-modern Den Haan cables are saturated with anti-corrosion and greasing materials.

This impregnation is, in fact one of the secrets of the success of these Dutch cables.

In addition to the standard galvanizing of the material an extra heavy zinc application, the so-called "Duracoat zincing," can be applied. Smaller or thinner cables can be given a coating of Akulon, one of the latest wear-and-tear resistant polyamide synthetic resins.

Just as in former days, Dutch ships found their way all around the globe and Dutch sail makers and rope makers worked for the world market, so today Den Haan ropes and cables have found markets in the United States and Australia, in Pakistan and Finland, in Italy and Britain—for Den Haan works for the world.

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New York, , 19

AMERICAN PETROLEUM INSTITUTE,

Secretary.

Observator N. V.

Meters and gauges for the world's industries

It is a commonplace to state that in this twentieth century manufacturing techniques have grown steadily in the direction of ever higher precision. This is due in no small measure to the great progress made in the techniques of measurement whereby nowadays an unprecedented precision can be achieved. It is also true to state that no modern industry can progress without using modern measuring methods and devices.

Research laboratories and manufacturers of measuring equipment in the Netherlands have been giving continuous and unremitting attention to the perfection of measuring techniques. This is the background behind the products of N. V. Observator of Rotterdam, a firm which has specialized for many years in the supply of manometers, temperature gauges, tank contents gauges and various types of flowmeters for world industry.

All Observator meters show specialization in either construction or finish, and cover every field. Of particular interest to the oil industry are their pressure gauges and mercury dial thermometers, some details of which are given below.

a. Pressure gauges

These high quality gauges comply with the cost exacting requirements of the Oil and Chemical industries; first class workmanship is expressed in every detail.

The gauges are resistant to humidity and chemical gases, and are robustly made to stand the rough handling which cannot be avoided in the oil industry. Nevertheless a high grade of accuracy is maintained.

The bourdon tubes are pressed and welded to the connection piece with great accuracy, and show practically no hysteresis.

Observator pressure gauges can also be supplied on request entirely in stainless steel, that is to say case, movement and connection.

Observator gauges to withstand pulsations and vibrations are supplied with stainless steel pressure elements and capillary damping, and are so designed that the medium to be measured is instated from the bourdon tube. Membrane gauges with protecting covering material (teflon) are also available. All gauges meet the most stringent specifications, including those of the American Standards Association.

b. Thermometers

Strongly made with stainless steel movement, stainless steel stems and thermo-wells giving great accuracy.

Manufactured to meet A.S.A. and other official specifications. The mercury system responds immediately to the slightest temperature change at the bulb.

These thermometers are dustproof, weatherproof and watertight, and include stainless steel cases filled with special oil, resin engraved dials, long capillary tubing, and invar temperature compensation.

All Observator products are hallmarked by the precision of Dutch craftsmanship and the choice of the finest material, all based on a knowledge of measuring technique founded on Netherlands scientific research.

Wilton-Fijenoord

Schiedam-Holland

History

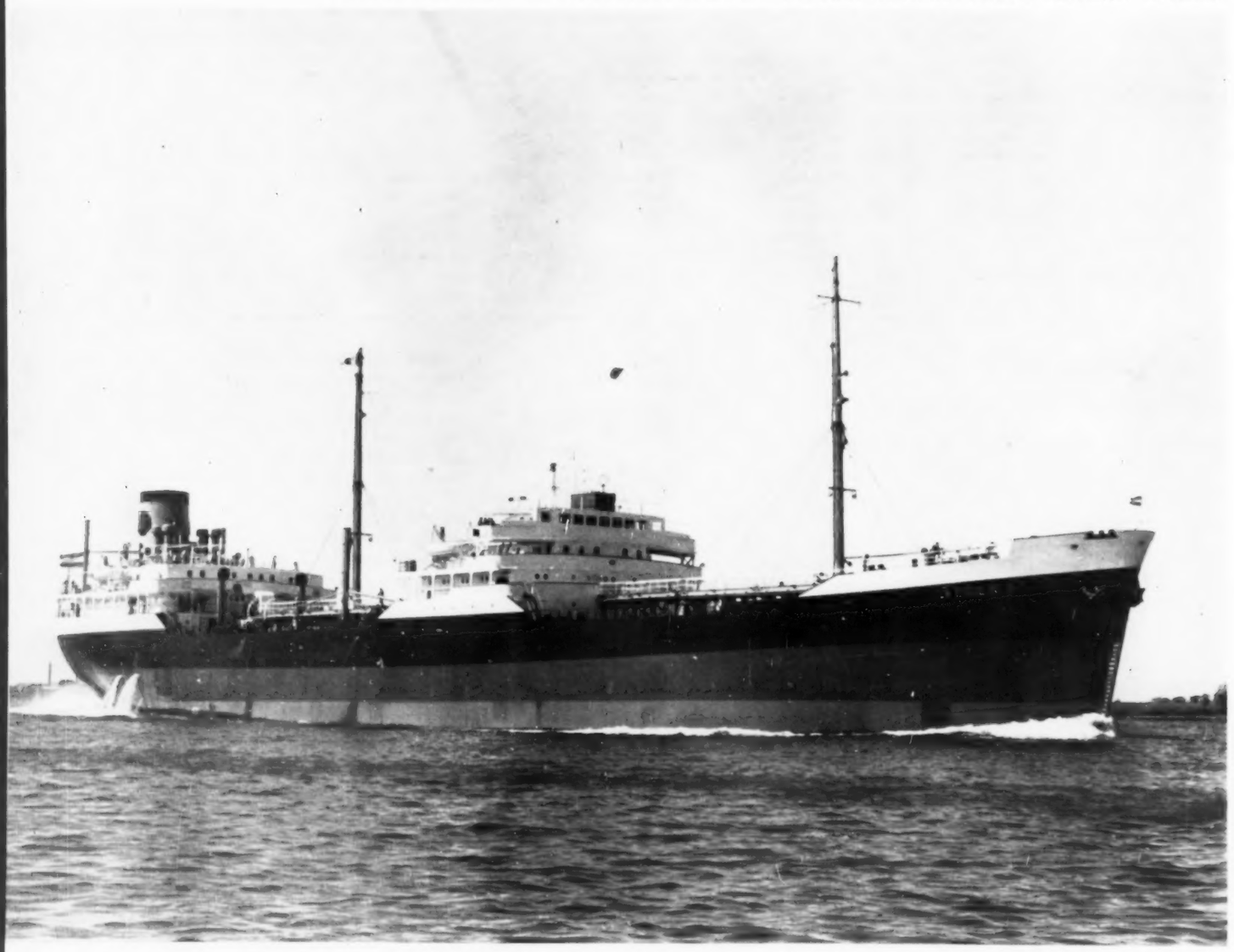
In 1854 Mr. Bartel Wilton started a modest smithy in the center of Rotterdam. In 1875 repair jobs for sea and rivercraft and ship's engines were taken in hand when small workshops were erected on the North bank of the river Meuse and the firm became known as Wilton's Engineering & Slipway Co. After a quarter of a century the ever increasing activities of the firm led her to occupy new sites along this river and in 1918 a further move was made to Schiedam. Here 170 acres of land were acquired to meet future expansion.

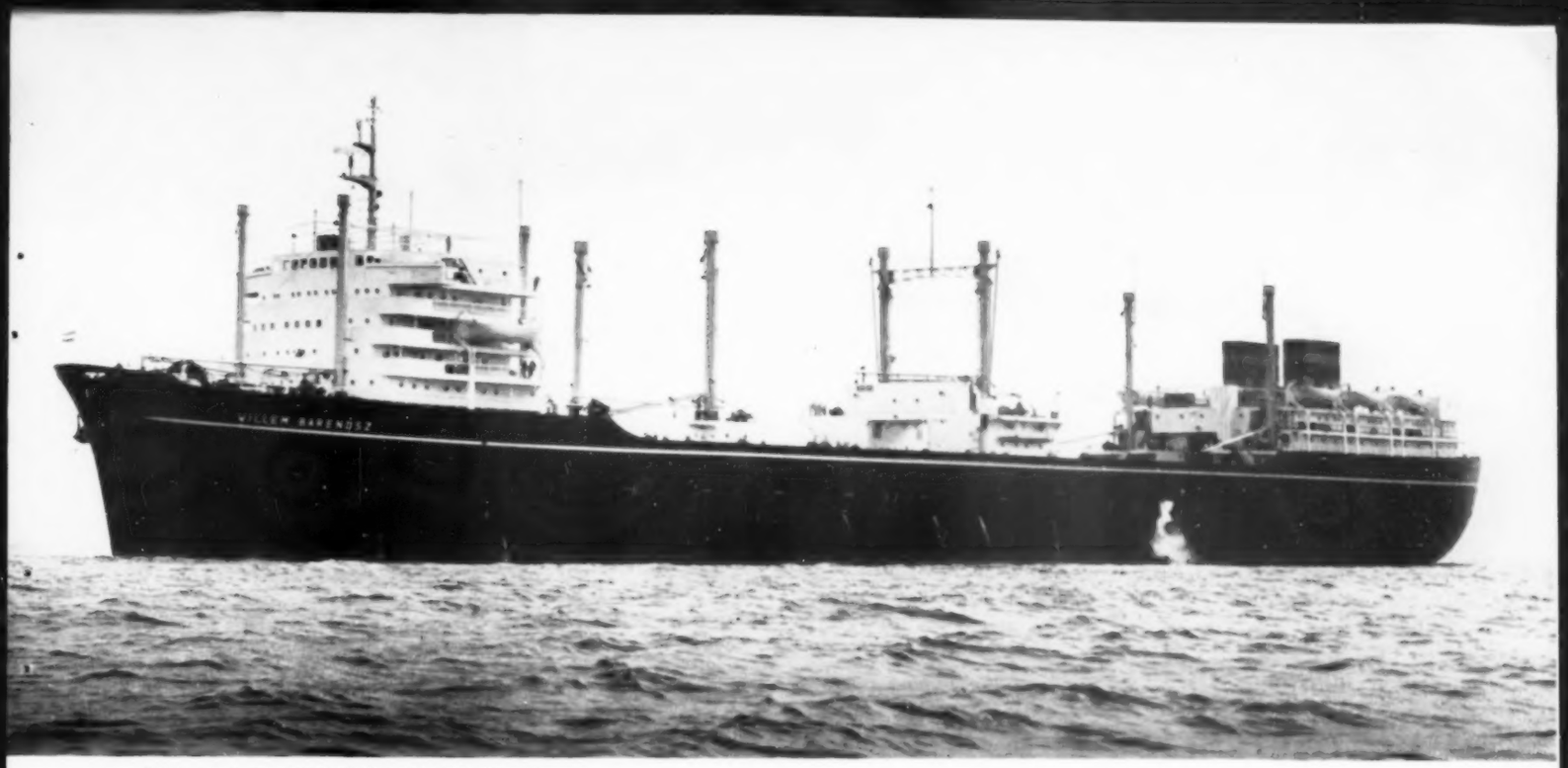
In 1929 Wilton's Engineering & Slipway Co. merged with the "Fijenoord" Shipbuilding and Engineering Company. This latter company, the oldest engineering works in the Netherlands, was founded as far back as 1823 and took its origin in the Netherlands Steamship Company established by Gerhard Moritz Roentgen, the inventor of the compound steam engine. In 1933 the Fijenoord Company left the sites occupied at Rotterdam for more than a century and moved to the modern works at Schiedam.

The present yard

At present the Wilton-Fijenoord yard at Schiedam has its own tidal docks covering an area of 34½ acres. For the building of ships the following facilities are available: a double graving dock, an entirely reinforced concrete structure, 650 feet in length and 280 feet in width, and also four berths, the largest one with a length of 540 feet, which can be lengthened for building ships up to 65,000 tons dead weight. Two berths are covered to facilitate the building of submarines. The Wilton-Fijenoord yard is well equipped to build both mercantile vessels—tankers, cargo

Turbine tanker "Kotenia," 13000 dwt. W.F. Parsetrada turbine of 7500 S.H.P. Owners: N.V. Petroleum Maatschappij "La Corona."





Whale oil factory vessel "William Barendsz," water displacement 44,000 t., 26,500 dwt. Two W.F./M.A.N. engines, each 5,250 S.H.P. Owners: Nederlandsche Maatschappij voor de Walvisvart N.V., Amsterdam.

ships and passenger lines, warships of all types—cruisers, destroyers, submarines etc. Among the vessels completed during the last few years are the large whaling factory ship "William Barendsz," the cruiser "De Ruyter," the 32,000-ton tanker "Caltex Rotterdam" and the passenger liner "Statendam" for the Holland-America Line.

For repair jobs Wilton-Fijenoord owns five floating docks, with accommodation for ships from 5,000 up to 85,000 dwt. Further, for repairing purposes there are also two graving docks for vessels up to about 38,000 dwt.

Three floating cranes, of which the largest one, the "Titan" has a lifting capacity of 100 tons, are continually in action for transport of heavy parts.

Machinery department

The concern also specializes in building ship propulsion engines and their big M.A.N. and Doxford diesel engines are well known products. In order to step up production the machine shops are equipped with the most modern tools, whilst a special testing stand is available for testing out the new diesel engines, thus ensuring that products are delivered which meet the most severe requirements. The machinery department also constructs under license Pametrada type steam turbines and Foster Wheeler type marine steam boilers.

A metallurgical laboratory for the testing of materials makes an important contribution to the aim of turning out only first rate products.

The number of employees is about 6,800.

Present acreage: total yards area: 275 (total harbor area: 75).

Motor tanker "Lorraine," 26,890 dwt. W.F./Doxford engine of 9,750 S.H.P. Owners: Societe Francaise de Transports Petroliers.

Turbine tanker "Caltex Rotterdam," 32,000 dwt. W.F./Pametrada turbine of 12,500 S.H.P. Owners: N.V. Nederlandsche Pacific Tankvaart Maatschappij.

Holland's engineering industries

In 1870, the year of the Franco-German War, Dutch engineers built the largest railway bridge in Europe, the bridge across the Moerdijk, which spans a stretch of water almost one mile across with 14 arches each of about 325 feet. As is well known, the Netherlands is crisscrossed by hundreds of rivers and canals, all of which had to be spanned by iron or steel bridges when the railways arrived during the course of the previous century. It was from bridge-building that the Dutch laid the foundations of their wide experience in all forms of structural engineering. Today this vast experience is the focal point of one of the most important groups in the metal industry, namely that of plate working and structural engineering.

Netherlands engineering industries at the present time have together an annual turnover of more than £8,500,000,000 or about $2,230,000,000, which is more than one-quarter of the turnover of the whole of Netherlands industrial enterprises; all together they form the first and largest industrial sector in Holland.

Since the end of the Second World War and especially during the past five years the growth of this sector of Dutch industry has been more rapid and more extensive than that of any other industry in the country. More than one-third of all industrial workers in the Netherlands find work in it, whilst its output produces about one-third of the total industrial export.

The most important group in the engineering sector is that concerned with transport —ships, cranes, railways, trucks and aircraft—with a turnover of about one-fourth of that of the whole engineering industry. Alongside this in almost equal groups are machine steel construction, the metallurgical industry, electro-technical production and the iron, steel and metalware industry. As regards exports however, the electro-technical industry stands first, followed by transport and machine steel construction.

The electro-technical industry began to grow in the Netherlands in 1870 at about the same time that the large electro-technical concerns in America, England and Germany started to develop. But it originated primarily as a supplier of its own home market. From the beginning it had special relations with shipping; ship's lighting was the first electric lighting, whilst the manufacture of electric lifting apparatus on ships was another important activity of the Dutch industry. In the latter years of the 19th century and the early years of he 20th century, however, the industry expanded its production to meet the rapidly growing electrification of the Netherlands. In later years diesel-electric aggregates and switchboard material assumed an important place in the production program.

Machine engineering found an important customer in the traditional shipbuilding industry. It started with the manufacture of steam engines, but immediately the diesel engine was proved practical, before the beginning of the present century, the production of diesel engines began on a large scale in the Netherlands.

The first sea-going vessel in the world with diesel propulsion was built in the Netherlands in 1901. Then came turbines, and in connection with the growing electrification of the country there came compressors and especially pumps. The pump was in fact one of Holland's first engineering products: it was a vital factor in the perpetual battle of the Low Countries against the sea (much of Holland is well below sea level). As a result, the Dutch engineering industry has a particularly wide and varied experience in the manufacture of pumps.

The production of various means of transport is another traditional specialty of Dutch industry: not only ships of all sizes and types, but also trucks and aircraft, with the name of Fokker taking an important place in the annuals of the conquest of the air.

From the combination of shipbuilding experience and the special requirements demanded by river improvement and harbor construction, a world industry gradually developed in Holland in the manufacture of dredging equipment.

Water and shipping in their turn led to the manufacture of dock cranes, followed by every conceivable type of fixed and floating lifting equipment. From the fact that all buildings in the western part of the country had to be built on piles driven deep into the ground pile-driving equipment was developed and later boring installations and equipment of all forms. The historic relation of the country to the oil industry, intensified greatly after 1890, laid the foundation of a strongly expanding industry for the design and manufacture of special machines, and equipment for the world oil industry.

Research

Holland has long been a great trading country, and in recent times the idea has gained ground that often the selling of a machine was more important, and perhaps more difficult, than making it. This often meant that attention was concentrated more on sales than on the actual manufacture. But it was soon recognized that the technological aspect had to be given first place, with the result that centralized and concentrated research steadily developed in Holland to a degree that has brought it to the level of technical research reached in almost any other country. With the many small firms—a typical feature of the Netherlands engineering industry—it was recognized that really large-scale technical research could only be achieved on a basis of cooperation. That is why, in spite of the individualism of the large industries in Holland which have their own research laboratories, centralized research has been particularly developed.

Three groupings play an important role in this respect: the Central Council for Applied Scientific Research (T.N.O.), the Association for the Testing of Electric Material (K.E.M.A.), and the Central Institute for Industrial Development (C.I.V.I.).

The T.N.O. was established by the Government with the cooperation of industry just before the Second World War, and it has had a special significance for the engineering industries. One or two results of its research of particular importance for the metal-working industries may be mentioned here: a polishing method which does in 15 seconds what had previously taken 35 minutes and the development of methods of erecting

heavy machines to make them vibration-proof; there has also been extensive research in the field of oil burners. In short, the whole of Netherlands industry owes much of its present high standard to the ever-widening research of T.N.O.

The K.E.M.A. organization was established in 1927 as a central approving authority for the makers and users of electrical installations and equipment. In the course of the years, however, its work has expanded considerably and at the present time it carries out many different forms of research and testing for both home and foreign industries, and especially for industries and enterprises using any form of electrical equipment or material. Among its many activities, for example, are the approving and testing of electrical instruments, material and installations used by the Royal Dutch Shell Group, the Netherlands Blast Furnaces, and large electricity plants in Ireland, Germany, Norway, Spain and South America to mention a few. The K.E.M.A. is the official agent for the Canadian Standard Association Testing Laboratories for the approval of electrotechnical equipment to be imported into Canada, and is also the approving body for the U.S. Underwriters Laboratories in Chicago.

Moreover, it keeps well up with the times in every way, the latest instance of this being its new laboratory for nuclear energy research. A wet homogeneous suspension reactor of its own design has been developed which is claimed to be more economic than heterogeneous reactors developed elsewhere.

The third central research body, the C.I.V.I., is an organization instituted by the Government to carry out research for Dutch industry especially in the economic-technological field, to increase productivity and to aid in the manufacture of new products.

Concentration and cooperation

Dutch industry, and especially the engineering industry, originated as private enterprises and has also developed mainly by private enterprise. There are no vast trusts or mergers in the Netherlands such as are known in many other countries. And the signs are that Dutch industry will continue to keep its freedom in these respects.

This does not mean however that there is no cooperation between different firms. The circumstances of the past few years, indeed, have led to a new form of cooperation among the firms large and small, namely, cooperation for export, cooperation to promote a better rationalization of the types to be manufactured, and cooperation which led to specialization.

An outstanding instance of this policy can be seen in the way all the producers of materials, machines and equipment for the oil industry have united in the group called the Netherlands Oil Equipment Manufacturers, N.O.E.M. Another and even more intensive form of cooperation is to be seen in NECOMA, an organization in which a number of manufacturing firms have concentrated their export interests. The important electro-technical industries, on the same principle, set up the Holland Electric Industry Export Association, whilst I.H.C. Holland is a similar group formed by a number of shipbuilding yards and the manufacturers of dredging and harbor equipment such as fixed and floating cranes. In all of these, larger projects are being executed than any one independent enterprise could hope to undertake.

Yet all these forms of cooperation have not led to any form of trusts. The Dutch industrial leaders desire, and intend, to remain completely independent in the matter of production. They know, especially in the engineering industry that only two factors govern sales: competitive prices and high quality. And these, therefore, are their main aims.

Structural engineering as a speciality

De Vries Robbé & Co. N. V.

There is a Dutch proverb which says: By mistakes and disgraces, one becomes wise. But perhaps real wisdom is to be found by learning from the mistakes of others.

It was in this way that the firm of de Vries Robbé learned the right way to technical perfection at the beginnirg of this century. For in the 75 years during which de Vries Robbé grew from a very small machine shop to one of the largest structural engineering firms in the Netherlands, certain other works then engaged in similar activity had to close down: their old-fashioned methods could not compete with the requirements of new times.

In those early years, however, structural work was only a sideline. It was only after the founder learned of new methods being used in the United States and other countries, and new industrial principles being introduced, that the basis was laid for industrial management along scientific lines, in which the center of gravity was moved from the workshop to the drawing board and the project office.

De Vries Robbé were the first and the largest structural engineers to specialize in a technique which previously was merely just a part of the ordinary factory work.

Even at the beginning of the present century very special attention was paid in the factory at Gorinchem to the value of design. And so it has been right up to the present day, when there are about 200 designers and draftsmen at work to ensure that from the very outset of each job the quality of the construction work will be essentially determined by the amount of time and attention given to the designs and blue prints.

In addition, however, the quality is also assured by the scientific work done in the de Vries Robbé laboratory, in which a great deal of research is carried out, and the firm's products are tested and checked. Chemical, mechancial, microscopic, metallurgical, ultrasonic and X-ray techniques play their parts in this important activity.

Because of this care and specialized attention, de Vries Robbé is at present the only constructional engineering firm in the Netherlands that supplies oil derricks carrying the certificate of the American Petroleum Institute.

De Vries Robbé has now built up a business which, at first in the Netherlands but later also in Indonesia and South Africa, supplies the most diverse forms of construction work in keeping with the most modern technical developments, all over the world.

The international activity of Dutch trade, in the past as well as today, the operation of its own oil industry far outside its own narrow borders, the initiative of Dutch planters and companies all over the globe, the enterprise of Dutch hydrological experts and civil engineers in a hundred lands—these have all given Netherlands industry a tremendous working area and provided a wealth of experience far exceeding that of any other small country.

It is in this way that de Vries Robbé has built up its great reputation in the building of bridges in the Far East, Africa and South America, steel construction work for oil refineries in the Far East, gasometers and storage tanks of ever-growing size, and the application in later years of systems of automatic seam welding in the field.

No matter what structural work is needed, and no matter where it is to be situated, de Vries Robbé can supply it in the highest quality.

United Engineering Works V. M. F. Stork-Werkspoor

In 1954, the two largest Dutch machine engineering works, namely the *Koninklijke Machinefabriek Gebr. Stork en Co. N.V.* and *Werkspoor N.V.* merged into the United Engineering Works, "V.M.F. Stork—Werkspoor."

All the experience of machine builders gained over a period of more than 125 years, all technical knowledge, all sales facilities, as well as a force of 20,000 artisans, were combined into *one* group.

Werkspoor

In the year 1827, Paul van Vlissingen founded a factory for steam engines and other tools in Amsterdam, Holland's first port and trading city. In the workshops of the United East India Company, where in the seventeenth and eighteenth centuries the world renowned East-Indiamen were built, the first steam engines were built and repaired for a new era of Dutch shipping and trade.

Werkspoor is situated on the premises where once upon a time Czar Peter the Great of Russia came to learn the art of building ships in Amsterdam. Instead of galleons, diesel engines, turbines and equipment for the chemical and petroleum industries are now manufactured. When the diesel engine began to be introduced as a prime mover, Werkspoor started the manufacture of its own type. In the year 1910, the tanker *Vulcanus* of the Royal Dutch Shell—the first sea-going motor vessel in the world—was furnished with a Werkspoor diesel engine.

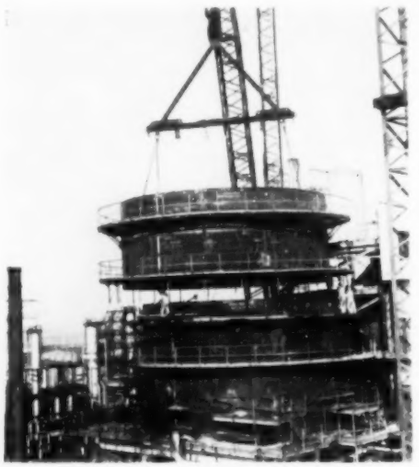
Since then, Werkspoor has designed and constructed numerous diesels: slow-running engines and fast-running engines, for shipping and for stationary use.

Since the founder, Paul van Vlissingen, was married to the daughter of a sugar planter, the young factory soon received contracts for boilers in sugar factories. In this way, the important sugar plant branch of Werkspoor came into being. Hundreds of complete sugar factories were installed in both the Eastern and Western hemispheres.

As a result of the experience gained in the sugar industry, the design, manufacture and construction of complete factories for the chemical and petroleum industries developed.

Of the extensive production program of Werkspoor for the petroleum industry, the following may be mentioned: complete installations such as gas plants, distillation units, asphalt plants, catalytic cracker, equipment for the Shell gasification process and fractionating columns of any size, with or without trays and caps.

When the Netherlands was liberated in 1945, numerous bridges and railway installations had been destroyed. During the repair of these, Werkspoor obtained great experience in the field of assembly and erection of steel structures. This resulted in the establishment of Werkspoor's Construction Department at Utrecht where rolling stock for the railway was built.

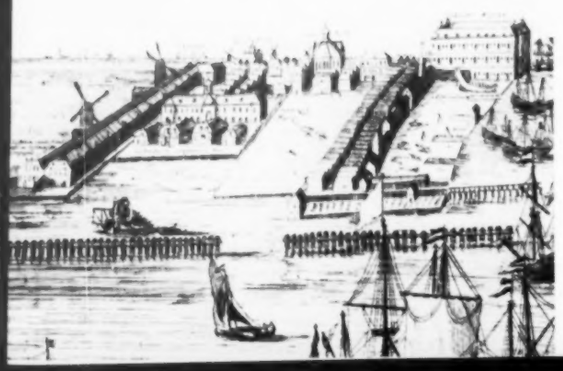


Erection at generator shell of fluid catalytic cracking unit.

Werkspoor's assembly activities for the whole world are centralized in this department. More than 2,000 men are permanently employed here.

For assembly work and erection in underdeveloped areas, use is often made of local labor, the workers being trained, where necessary, by Werkspoor. Werkspoor is renowned for quick deliveries and its economic use of labor.

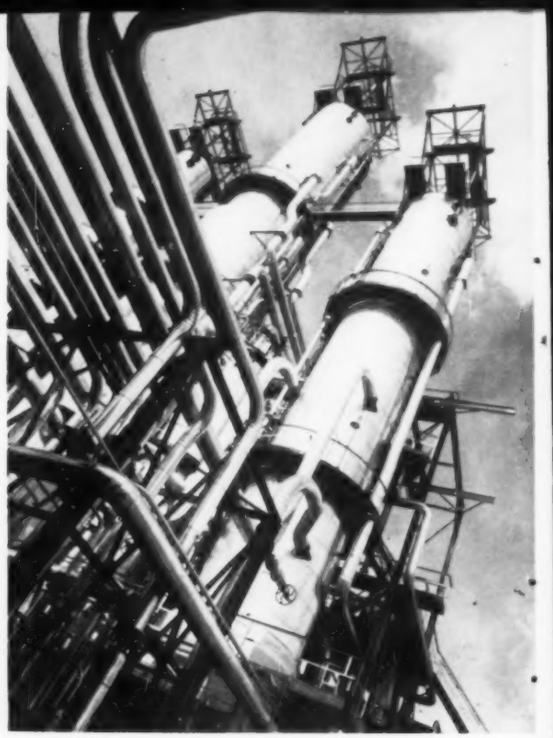
Refineries have arisen all over the old and the new world, in the erection of which Werkspoor has played a very important part. Werkspoor has its own offices in Australia, South Africa, Iran and Venezuela.



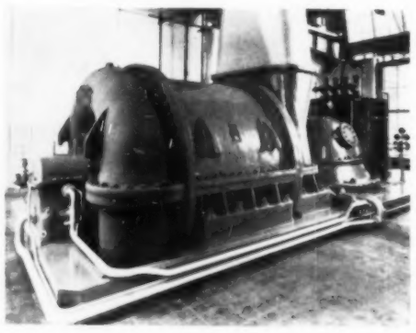
17th Century engraving at the site where Werkspoor was founded.

Stork Hengelo

The Koninklijke Machinefabriek Gebr. Stork en Co. N.V.—to give it its full name—was founded in 1868 as a modest little concern at Hengelo, in the East of the Netherlands. The initial purpose was to supply steam engines and boilers to the cotton mills in the immediate vicinity, but it was soon evident that Stork's small concern was too aggressive for such a limited market. Contracts were undertaken for the building of steam pumps which gradually came to replace the picturesque windmills hitherto used to drain the low-lying land in the western half of the country, much of it beneath sea level.



After 1883, Stork went on to build, in addition to steam engines and boilers, complete cane sugar refineries for the tropics. This opened up a great new field of endeavor and the factory grew into a medium sized concern.



Turbo-compressor.

After the turn of the century, the factory expanded its production program and became the first to build steam turbines in the Netherlands. Other products were watertube boilers, centrifugal pumps, fans and compressors.

Stork also gained a wide reputation as a producer of complete mechanical installations for electric power stations. In 1930 the firm began to build diesel motors. As a result

of all these activities the company quickly grew into a factory with a staff of 5,000.

For many of its products, Stork found a good market in the oil industry. Numerous orders were obtained over the years for pumps, compressors, turbines, boilers and engines.

In the field of pumps, Stork manufactures the whole range of centrifugal pumps used in oil refineries and in oil transportation. These pumps are exported to numerous countries.

Stork rotary compressors, often multi-stage machines with their high-precision rotors are well known everywhere. Most of these compressors are driven by Stork steam turbines of up to 10,000 hp.

In the field of boilers Stork booked numerous contracts for Babcock and Wilcox boilers in the Netherlands and its overseas territories.

Four-stroke diesel engines, especially suitable for generator installations in the oil fields, are manufactured by Stork with capacities from 120 to 500 hp at 600 to 750 rpm. These engines are built in series production. Stork also builds large two-stroke ships' diesel engines of its own type, with pressure filling, in all sizes up to 20,000. Various engines of this type are used in oil tankers.

Conrad-Stork

The Conrad Wharf was founded in 1883.

In 1932, the name was changed into *Werf Conrad en Stork Hijsch N.V.*, or, abbreviated, Conrad-Stork.

The Conrad Wharf soon gained a world-wide reputation for the building of dredging material and especially for gold and tin dredging mills so that it can be said without overstatement that all over the world where gold or tin is dredged, the products of the Conrad Wharf are found. To these products were soon added the drilling equipment necessary in the search for alluvial mineral deposits. For this purpose, the Conrad Wharf brought the well known Conrad-Banka, Meca-Banka and Conrad Pitt-digger on the world market.

Before the First World War, Conrad had already established its name as a specialist in drilling equipment for the petroleum industry. At that time, it was the only Netherlands firm to market drilling machines and quick percussion drilling tools.

Conrad also marketed heavy cable tool outfits of the Pennsylvania type.

Approximately thirty years ago, Conrad-Stork was a pioneer in introducing the first rotary drilling tools which were assembled on truck chassis and driven by the truck's engine.

Other pioneering work done by Conrad was the development of the so-called "counterflush" or reverse circulation continuous rotary coring system for investigating oil deposits, a system which, before the introduction of "electric logging," spread the name of Conrad-Stork to oil circles all over the world.

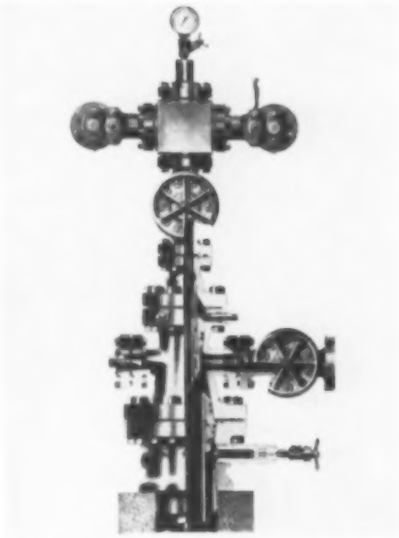
For seismic reconnaissance, Conrad-Stork developed over the last twenty years a series of special rigs which are exceptional for their modern design, light weight and easy transportation in every possible terrain. The light weight type of these shothole machines makes it possible to assemble or disassemble them within a few minutes. If necessary they can be moved in their entirety by helicopter. The heavier types are mounted on automobile chassis and are equipped with a mud pump and or a pre-circulation system with compressed air. Depending upon the requirements of the buyer, they can be equipped with mechanical, hydraulic or semi-hydraulic drive. As licenses outside the United States for the Gray Tool Company of Houston, Texas, Conrad-Stork manufactures, in addition, well-head assemblies and rotary swivels, using materials precisely equivalent to those specified in the catalogues of Gray Tool Company and the U.S. Composite Catalogue.

Stork-Jaffa

In 1952, the *N.V. Machinefabriek "Jaffa" (formerly Louis Smulders)* was taken over by the Stork concern and assumed the name of Stork-Jaffa. Since the end of the nineteenth century and even today, the factory is known as "Jaffa." The Hebrew word "Jaffa" means "beautiful country."

The concern owes its name to the beautiful countryside where the factory is situated in the surroundings of Utrecht. This district bore the name of "Jaffa" on a map dating from the year 1539.

The Dutch textile industry, which developed in the 19th century, was established in the east and in the south of the Netherlands; in both cases, these were regions where home weavers had already been acquainted with textile techniques. The founders of Jaffa came from the southern textile area but were led to direct their efforts in the metal industry. The Smulders family were metal workers in the south of Holland long before 1891, when the Jaffa factory was built near Utrecht.

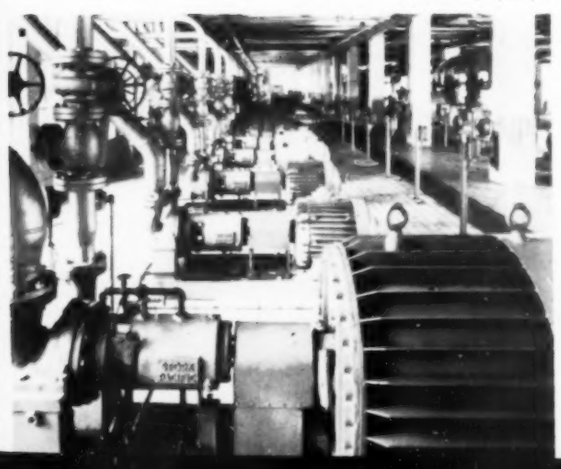


(Top) Drilling rig, mounted on automobile chassis.

(Bottom) Cut-away view of Conrad Stork complete well manifold assembly.

Steam engines, steam actuators for floodgates and bridges, travelling cranes, electric tackles, various transportation equipment and weight bridges and in particular pumps, these are items in the production program of Jaffa. In the year 1915 Jaffa delivered a polder drainage pump which then was the largest in Europe. Later, Jaffa also built pumps for submarines. In addition to a great variety of products, Jaffa also manufactures special pump parts and pumps for the oil industry. Since 1950, Jaffa has manufactured the Jaffa Red Devil slush pump and horizontal duplex slush pumps, well known in many oil fields.

Stork Pacific pumps.



Non-destructive testing and inspection
Röntgen Technische Dienst

Positioning an X-ray unit for the testing of material.

The *Röntgen Technische Dienst*, a private undertaking for the non-destructive investigation of materials, owes its existence to three factors: first, experience in the fields of physics and electronics; second, the active interest of industry in technical-scientific research, a feature that has characterized Dutch industry for many years; and finally, the tendency towards cooperation which developed after the second world war, particularly in the metal industry. Holland used to be and still is a country of shipbuilding and of engineering. In both of these industries welding techniques found ready acceptance and wide application. The need for a reliable method of non-destructive testing, especially for foundry work and for welded structures led to the application of X-ray radiographic techniques.

Almost all methods for the testing of materials yield results which show a considerable spread and moreover the interpretation and comparison of results is often a largely subjective process. In order to obtain reliable and objective interpretations of test data, which would be useful throughout the various industries, statistics became indispensable.

Extensive test data thus became necessary; only a comprehensive research and testing program based upon national *and* international cooperation, was therefore of value.

Ultrasonic testing of a welding seam in heavy plate material.

The *Röntgen Technische Dienst* was established before the second world war from the experience of Dutch shipbuilders and engine designers in welding techniques, with the technical backing of Dutch electronics engineers. It was founded as an independent private concern, and was allocated research commissions by an important cooperative group of shipbuilding undertakings; this gave it its initial financial footing. The work was soon greatly extended by the entry of other industrial undertakings. From the beginning great value was also attached to international contacts and the *Röntgen Technische Dienst* has, e.g., participated actively in the compilation of the atlas of welding faults of the International Institute of Welding, as well as in the investigations of *The Netherlands Welding Center*.

Work began with X-ray radiographic investigation of materials and made use of X-ray equipment manufactured by Dutch industry. Equipment and techniques have so developed that it is now possible to check welded joints in steel as thick as 30 mm with mobile X-ray equipment on board ship.

As soon as the availability of radioactive isotopes opened up the possibility of the gama radiography of materials during and after the second world war, the R.T.D. also commenced with the application of this method, particularly in the checking of pipe

joints and foundry work. Dutch research in the field of nuclear physics rendered important contributions to the techniques of this method.

The strong position of the Netherlands electronics industry contributed much to the development of another method of non-destructive testing, viz. ultrasonic investigation. With this method, too, it was necessary to carefully examine the interpretation in order to obtain a correct evaluation of results.

For this purpose a whole series of experiments were set up in which ultrasonic measurements were compared with the results of destructive investigations. As the quality of the images increased, the results compared better and better with other methods.

The Röntgen Technische Dienst now has command over such a vast field of experience that its measuring and test results can boast practically 100% reliability. Using particularly these ultrasonic techniques the R.T.D. expanded its activity in the oil industry. One of the most important developments was the investigation of pipe; testing could now be carried out actually on the production line. Commissioned by the oil industry, an apparatus has been developed by means of which the fast work of automatic welders can be completely checked. This generally involves a welding speed of about 1.20 to 1.60 meters per minute, although in some industries this rate is now considerably higher. The R.T.D. have built an automatic printing register which marks the results on the material itself.

This apparatus, developed in the Netherlands by the *Röntgen Technische Dienst*, is used by many factories abroad for control during production.

The R.T.D. ultrasonic system is used for the testing of pipe joints in Venezuela, Curacao, Burma, Australia, Borneo and Persia. Ultrasonic techniques are also used to determine the thicknesses of materials, and also for checking building structures where it enables corrosion to be detected in a simple manner.

Ultrasonic techniques involve the utilization of mechanical vibrations; its immediate connection with the theory of stressing of materials, opens up vast possibilities for these techniques in all material investigations—whether in the field or in the laboratory.

In the modern laboratory of the R.T.D. at Rotterdam special investigations are undertaken on behalf of Netherlands and foreign industries. With the general trend in recent years towards the use of new lighter materials a central investigation establishment equipped with the most refined and perfected apparatus for non-destructive testing is of the utmost value. Apart from this central laboratory, the world is the workshop for the R.T.D. Everywhere where the oil industry is active, the Netherlands *Röntgen Technische Dienst* is there to test and investigate.

J. Duiker & Co.

Manufacturers of fine instruments and burners

Duiker manufactures fine mechanical components and instruments and has furthermore a wide program in oil burner equipment.

Oil gas burners

Duiker oil gas burners are specially designed for oil refineries and chemical industries and are in use in many countries all over the world. They are available in ranges up to 2,000 kg per hour of fuel.

Duiker's experts, with the experience of many years in refinery practice, can give advice regarding the engineering of projects where oil gas burners are required, including burners for waste products such as acid sludge.

Duiker also specializes in automatic controlled burner installations. For domestic use there are large series of burners for light and medium heavy fuel oils, and ranges up to 100 kg hour oil and rotary cup burners, for heavy fuel oils, up to 350 kg hour.

Atomizers

Engineers in the petroleum and chemical industries are more and more concerned with atomization problems for liquid gas contact operations such as spray drying, gas scrubbing, liquid absorption or desorption, humidification, etc.

Duiker manufactures several atomizers for the above purposes, in ranges from 2-10,000 liters hour in different spray patterns and materials.

Orifice plates for flow measurements, all types

Duiker specializes in making quarter circle orifices.

Thermocouple assemblies of various types and mountains

Miscellaneous products:

Welding-bosses and unions with A.P.I. thread, unified boltings such as stud bolts and unions of special materials.

EMBA—Oil rig packers

Shipping and harbor facilities have made the Netherlanders outstanding in the rendering of maritime services, and three or four centuries of handling, transshipping and packing every conceivable type of goods have given the Dutch a wide experience in this form of activity. Moreover, this form of special service has created a particular mentality which ensures that in every transaction the business interests of the customer are always the first consideration.

EMBA, the large Netherlands manufacturer of cases, drums and cartons, has specialized in several unusual forms of packing, notably that of drilling rigs and other oil equipment which have to be transported across the ocean. This is of course not a matter of packing only. Transport facilities, stevedore and shipping facilities also play a very important part.

When, for example, an oil rig with all its spare parts had to be packed for transport to Africa, it was supposed by the principals that the rig would be sent as full cargo by a chartered vessel whilst the 200 cases of materials and parts, to be stocked about 130 miles from the actual drilling rig, would be sent later by an ordinary cargo boat. But by careful planning, EMBA succeeded in packing the whole equipment and transporting it to the coast so that it could be sent as a single cargo on the chartered ship. This involved a saving of the cost of more than 100 tons of freight.

EMBA packs such rigs complete with motors, pumps and compressors in cases made either in their own factories or at site. EMBA packs pipe in bundles, because several miles of piping can only be loaded and unloaded rapidly when transported in bundles. EMBA has its own specialized crews who pack, weigh and mark anywhere in the world. And so safe are these Dutch packers when it comes to global transport that under all circumstances and in all locations they prove the cheapest and the best, no matter whether the rig installations weigh 300 tons or 2,500 tons, or whether there are 100 or 600 cases to be packed and dispatched.

Van Doorne's automobile factory D.A.F.

Transport specialist

The 6,000-gallon semi-trailer which carries motor fuel or drinking water in Saudi Arabia

The 2,000-gallon aircraft refueller from which, at one of the many NATO airports in the Western World, jet planes are serviced

The lubricating-oil tank truck which threads its way through the overcrowded streets of Santiago, Chile

The trailer laden with diesel oil bumping over the half made roads of New Guinea

All these came from Europe's largest and most modern truck, trailer and tanker factory in the Dutch town of Eindhover, from the works of D.A.F. (van Doorne's Automobiel Fabriek).

Of the whole Netherlands engineering industry, that section which provides vehicles and ships takes first place, as regards volume. About one-quarter of all the metal manufacturing in Holland consists of ships or vehicles. Shipbuilding and repairing, of course, accounts for the greater part because it has grown out of Holland's traditional position as the world's carrier and trader. In more recent times Holland has earned for itself a name as the builder of a great variety of vehicles for road transport.

The worldwide users of D.A.F. trailers and semi-trailers probably do not associate the quality of these vehicles especially with the Dutch, for even in the Netherlands van Doorne's factory is unique. In it, enterprise, technical inventiveness and Dutch business ability have been merged to form a remarkable undertaking. The two brothers, Dr. Huub van Doorne the engineer, and Wim van Doorne the commercial leader and organizer, jointly personify all those qualities necessary to make a small vehicle works into an extensive industry supplying world markets.

It was about 30 years ago that the inventive spirit of Huub van Doorne showed itself in the opening in Eindhoven of a workshop designed mainly for the construction of trailers. Starting on the principle that an automobile motor, like a horse, can draw more than it can carry, the van Doornes decided to make trailers as their speciality, and very quickly won a place in the markets of the world.

Before the second world war D.A.F. had begun to produce cross country vehicles and armored cars for military use. Indeed, it was the almost insatiable demands of the army in the matter of vehicles that served as the spur to the van Doornes in developing one invention after another—a field in which the technical ingenuity of Huub van Doorne found practically unlimited scope. Even before 1940, D.A.F. inventions were being used under license in the products of factories in Britain, Czechoslovakia, Switzerland and Sweden.

After the first featherweight trailer there came the so-called D.A.F. unloader for railway cars, an ejecting motor sledge, and numerous other trailer modifications with their special features.

The war, of course, stopped production. Destruction during the war later provided the opportunity for complete reconstruction; within a year or two, D.A.F. was not only in full swing again but was rapidly forging ahead. For example, it presented the world with a rapid refuelling tanker for jet planes which reduced the time for that operation by a factor of ten. In competition with 13 other European firms D.A.F. won the order for the supply of such tank trucks to all the NATO air bases in Western Europe.

It was the oil industry that gave D.A.F. another great opportunity after the war when the transport of liquid fuels and gases rose unprecedently. It was, however, fortunate for the oil world that the Netherlands had already gained much experience in the transport of another much-used and bulky commodity—milk which, in fact is, still Holland's most important bulk commodity. And with Holland one of the world's largest producers and transporters of milk, it possessed the largest tank truck industry. The Netherlands was also the birthplace and the headquarters of one of the world's largest oil enterprises, the Royal Dutch Shell Group, which, again, is concerned with the transport of a bulk commodity.

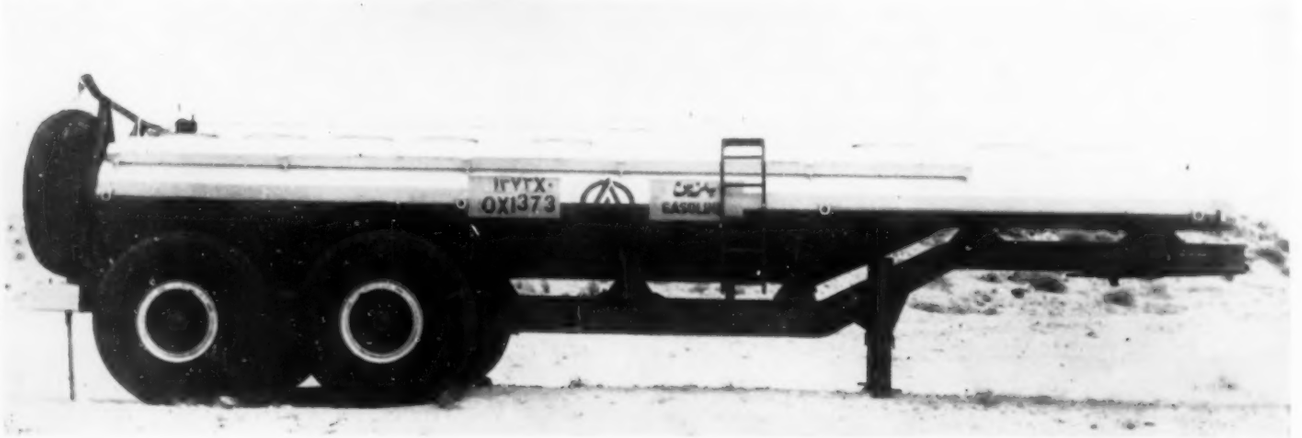
In the circumstances outlined above, the special knowledge and skills of D.A.F. grew into a great tank truck industry. The growth of this side of the firm's activity was further promoted by the many bulk products from Holland's heavy chemical industry—the Royal Netherlands Salt Industry and the States Mines in Limburg. The salt in the north has developed into a mammoth industry from which a host of bulk chemicals are produced, whilst the coal in the south formed the basis of a tremendous output of chemical by-products. The heavy chemical industry was thus a third contributory factor in the development of D.A.F. heavy transport vehicle production.

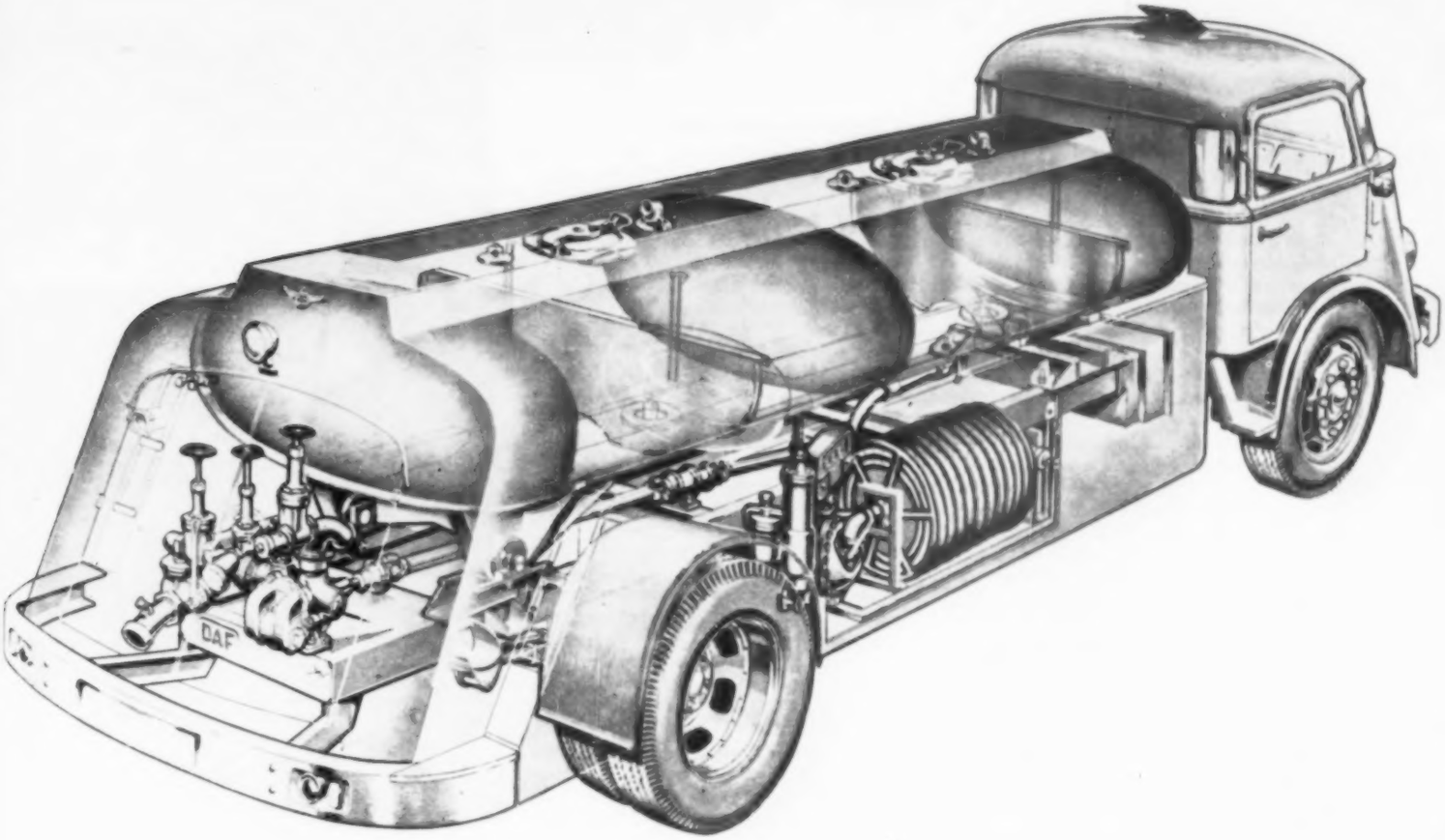
Despite these contributory factors, it seems certain that without the remarkable technical ability of Huub van Doorne—conferred with an honorary doctorate by Holland's University of Delft—the D.A.F. would never have grown into a world-wide concern.

D.A.F. enterprise has not been restricted to trailers and trucks. In March 1959 a newly built factory has turned out the first D.A.F. private car—a vehicle which presents as many new technical features as the many other D.A.F. products, and a worthy "little brother" to the great family of trucks and trailers.

The world wide reputation of D.A.F., however, is largely owed to the series of tank

A 6,000 gallon DAF tanker in the desert.





A standard fuel oil and gasoline tank truck (1950 U.S. gallons) for delivery of gasoline and domestic fuel oil in moderate quantities.

trucks devised for the many liquids and gases arising from the expanding oil industry. All these vehicles carry the stamp of quality, a hallmark of Dutch products.

Tankers for petroleum transport, of course, have special features. To give them the lowest possible center of gravity, the tanks are of elliptic section; also the weight of the chassis and the tanks must be kept as low as possible, without interfering with the strength of the whole structure, a problem which has had the special attention of D.A.F. engineers for years. For the transport of crude oil the tank must be of maximum size, so that the semi-trailer type of vehicle (articulated truck) is especially suitable.

The safety factor is of vital importance for the transport of gasoline, kerosine, diesel oil, etc. In this connection Dutch law stipulates very stringent requirements: (a gasoline tanker, for example, must not have larger compartments than will accommodate 800 U.S. gallons); all tankers must be supplied with special impact rails for protection in the event of collision, and strict precautions are necessary for the construction and operation of the safety valve and the emergency valve. All this means that a maximum of safety is "built-in" these D.A.F. products.

The tanks for special products are, of course, provided with a variety of pumping and piping equipment, whilst the special D.A.F. swing axle suspension on the semi-trailers means that even on rounded roads the tires are always aligned at right angles to the road surface.

Semi-trailers are supplied for weights ranging from 28,885 lbs to 49,612 lbs, according to the demands of Dutch law. For the world market they are supplied up to an axle load of 44,100 lbs. Another important feature which distinguishes the D.A.F. semi-trailer is that the tandem axle unit is fitted with a compensating device which equalizes the load during travel and braking over the front and rear axles.

The whole extensive production program of the D.A.F. factories is a typical example of Dutch technical inventiveness combined with the spirit of enterprise, commercial insight and industrial experience, all available at the right moment for the world oil industry.

A giant drill ring tender. Cross country transport of drill pipe, drill collars and other drilling equipment.

NECOMA — Stichting Nederlands Exportbureau van Constructie- en Machinefabrieken

"Unity is strength"

This guiding principle brought numerous Dutch engineering industries into closer cooperation in the years after the Second World War. Of this cooperation, NECOMA—the joint export center for eleven well-known Dutch engineering industries—is a fruitful example.

In NECOMA, large construction workshops and machine factories, factories making pumps, heavy cranes, boilers and piping are all fused into one group. A group which, because of its technical potential and financial backing can undertake the largest of projects all over the world. In all these projects, one member of the group normally acts as the contractor; sometimes, however, five or six members of the group will work together on one contract. All are specialists in their several fields; the one with centuries of experience in the building of bridges, another with special practical knowledge of the construction of heavy buildings drilling rig foundations have come to be a speciality of the group and the variety of the pumps made by the group have led to the gradual expansion of the market for this typical Dutch industrial product.

Development in the direction of the construction of larger and larger objects is also partly due to the fact that industrial development abroad has made it possible for the simpler, smaller products to be manufactured locally. For this reason it has been a good proposition for Netherlands industries to concentrate more and more on specialities and very large works. The contracts undertaken by NECOMA all over the world therefore usually involve the building of large complete plants or the supply of special machines, e.g. special pumps, boilers or chains, all important items in the production program of NECOMA members.

In this typical Dutch industrial group the unusual historical development of the Dutch machine and metal-working industry is also apparent. With the need for dikes and land-drainage and for the needs of the ships of this seafaring nation the Netherlands have used pumps since bygone ages, and the "polder" pump devised long ago in the Low Countries, later developed into irrigation pumps, drainage pumps and pumps for a variety of purposes. In the Dutch salt and soda industries, additional experience has been gained in making pumps for a variety of chemicals. The great know-how of the Dutch State Mines in the field of nitrogen production become one of the technical-economic foundations for many special products of the NECOMA group.

The requirements of the great Dutch oil industry, led member firms of the NECOMA group to direct special attention during the last half century to the manufacture of equipment for the world oil industry. From experience in structural engineering, members of the group have developed their position as constructors of drilling rig foundations in deep water, an activity particularly appropriate for the Dutch.

Boiler manufacture led to the production of all types of tubular vessels, coolers, condensers and heat exchangers. Pipelines, prefab process piping, columns for high and low pressures and boilers of all capacities, are supplied to the world oil industry. Above all, the group delivers an astonishing diversity of pumps, pumps for oil products, for acids or lyes, pumps for sludge and slurries and cooling water pumps of large capacity.

One of the latest developments is a type of pump which is suitable for liquids over a whole range of viscosities. In the NECOMA group the age-old relations between shipping, shipbuilding and the engineering industries in the Netherlands led also to the manufacture of special heavy chains and special anchor types.

Machinefabriek Pannevis

Almost half of Holland would be submerged under water if there were no dykes and no polder pumps. The *Machinefabriek Pannevis* is one of the Dutch undertakings which makes the drainage of the low Dutch polder land possible.

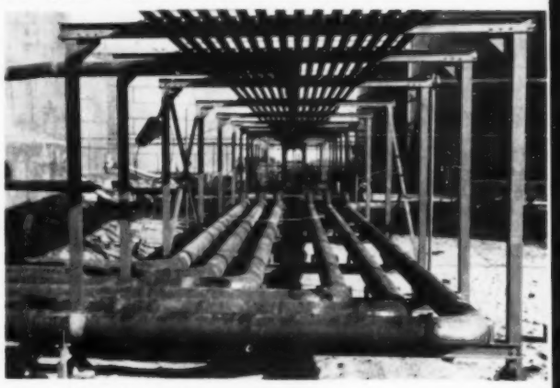
In the course of the first half of the twentieth century, Pannevis produced more than 200 pumping plants with a total capacity of more than one million gallons per minute! Against the background of this enormous capacity, Pannevis has developed the manufacture of other types of pumps and water cooling plants. In addition, however, Pannevis also manufactures steam engines, steel constructions and, in particular, overhead travelling cranes.

This versatility renders important contributions to the construction of extensive installations in the wider sphere of NECOMA.

Hollandsche Constructiewerkplaatsen

Around the year 1880 Dutch entrepreneurs entered upon a period of special activity in the Dutch East Indies. Along with the development of plantations grew the need for steel structures and better railway connections and bridges.

As a result of the building of bridges in the home country, the Netherlands had gathered a great fund of experience in the field of steel structures; the development of industrial activity in the Indian Archipelago brought contracts, and with them experience, to the Dutch construction workshops for many years. The *Hollandsche Constructiewerkplaatsen* with their special knowledge made important contributions to all this development in the Dutch territories. They have remained specialists up to the present day, and when, in the years around 1929, the relatively new techniques of welding opened up new production possibilities in the engineering industry, they were developed by a subsidiary company, the *Nederlandsche Electrolasch Mij.* The experience of the firm in steel structural work finds its outlet in the building of factory skeletons and steel superstructures, in the construction of boiler houses for electric power plants, and scaffoldings and landings for catalytic cracking plants. In the wider Necoma context, this special experience in custom-built structural work assumes special significance.



(Top) Dehexanizer Column.

(Bottom) Storage-tanks and piping for oil plant, supplied by Late E. H. Begemann-Helmond (Holland)

Kloos en Zonen's Werkplaatsen N.V.

Rembrandt made some of his most beautiful etchings with the Amsterdam windmills as his subject. Today, hundreds of thousands of tourists still visit the low countries by the sea to see the many windmills which lend a special beauty to the landscape.

The Dutch windmills, originally water-pumping mills and later flour and saw mills, were among the first important mechanical installations in Holland. More than a hunderd years ago, in this land of wind and water *Kloos en Zonen's Werkplaatsen N.V.* was founded at a spot where the river Rhine meets the sea. Here were situated scores of shipping wharves, which served the rapidly growing Dutch East Indies fleet in the first half of the previous century. The remarkable shipbuilding activity of those days occasioned the need for more and more saw mills: every wharf wanted its own wind mill. Floris Kloos settled in these parts as a builder of mills. On the identical spot where Floris Kloos built his first wind mills in 1843, the large factory halls of *Kloos en Zonen's Werkplaatsen* now stand.

From being a builder of mills, Floris Kloos became a builder of ships; from the building of iron ships he went on to build floodgates and bridges. Bridge construction brought

with it experience in the erection of enormous steel structures far from the factory site: seventy five years ago, Kloos transported the complete span of a bridge over the river IJsel to its destination by lighter, 200 km from the factory site.

This occurred at a time when the extension of the railways made necessary the building of many bridges across rivers and canals. Steel bridges were primarily railroad bridges; this relation between Kloos and the railroads led to the production of railroad material, from points to line crossings. One thing led to another. Steel construction and its relation to shipping and shipbuilding led to specialization in the construction of floating cranes and bridges.

This whole fund of experience over a period of more than a hundred years, all the acquired technical knowledge, all the talent for organization are today used in the services which Kloos, through the NECOMA group, renders inside and especially outside the Netherlands to the world oil industry.

Nederlandsche Electrolasch Maatschappij N.V.

When, in the years after 1920, the technique of welding came to be more and more used in industry and welded construction came to replace much riveted work, the *Hollandsche Constructiewerkplaatsen*, one of the members of NECOMA, decided to establish a daughter company which would devote itself mainly to the manufacture of welded structures, machines and equipment. In this way the *Nederlandsche Electrolasch Maatschappij* came into being. It owes its particular experience to the employment of a staff specialized in the field of high pressure pipelines, complete boiler house installations, and water purification works. In the field of boilers, this firm developed the N.E.M. water tube boiler, an individual type embodying a completely new method of construction—a fact that distinguishes it from most other smaller boiler types which are usually simply smaller editions of larger models. The N.E.M. water tube boiler has a remarkably compact construction and has a particularly high steam production for its small size. The whole boiler is welded electrically. Electric welding is the technical foundation of the whole activity of the *Nederlandsche Electrolasch Maatschappij*. The firm developed welded pipelines in which the welding and annealing are completely adapted to the type of material and the pipeline system. On this basis, the N.E.M. also manufactures prefabricated process piping for low and high pressure from ordinary or alloy steels, and for all kinds of liquid, gas and steam.

Above all, however, *Electrolasch* is a specialist in the manufacture of equipment for the petroleum and chemical industries: columns, high pressure plants, tubular vessels etc.

Houttuin's Machinefabriek

At a time when technical development in some European countries and America was proceeding slowly because of a lack of a sufficiently developed market, two economic factors existed in the Netherlands to act as an immediate stimulus to the young engineering industry: shipbuilding and the drainage of polders. Since time immemorial, wood has been the major material for the construction of wind mills; metals, however, were used for the water pumps driven by these mills.

The vital need for water pumps partly explains the variety in pump production of Netherlands industry as a whole. In the case of Houttuin, the development followed a slightly different road. This led to the development of pumps of a special type.

The outstanding features of Houttuin pumps may be expressed by the latest Houttuin type, a pump suitable for liquids of any viscosity. Seawater, heavy lubricating oil, even asphalt, can be handled by one and the same Houttuin pump. It is a very useful pump especially in lubricating oil plants and on board tankers, as a cargo pump, a stripping pump, a ballast pump or a bilge pump.

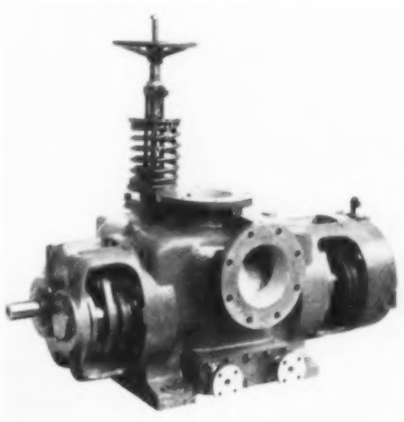
Koninklijke Nederlandsche Machinefabriek v/h E.H. Begemann

When, after the French-German war of 1870-1871, industry in Germany and Holland underwent an ever increasing rate of development, the Dutch entrepreneur frequently set his factory in the country, where the wage and living standards were lower than in great cities in the Western provinces of Holland.

At this time, Egbert Haverkamp Begemann erected a steam engine factory in Helmond, the growing textile and industrial center in the south of Holland. From steam engines, the firm went on to driving gear, boilers and tanks and, in particular, also pumps. The new steam drainage pumps for the Netherlands "polder" land had to be furnished with modern equipment.

A few years later, Begemann also went over to structural engineering and the building of bridges. The East Indies, where Dutch enterprise has led to new railways, new plantations and new factories, became a growing market for Dutch industry in the years after 1880. One of the biggest contracts obtained by the youthful Begemann firm was for the building of no less than twenty railway bridges on the island of Java. Siam too ordered railway bridges from the Helmond firm. The roof framework for the Peace Palace in The Hague, a gift of Andrew Carnegie, was constructed by Begemann's, by that time honored with the title "Royal" before its name. In the collective activity of the NECOMA organization, Begemann contributes in the form of structural engineering. First and foremost, however, the Begemann concern manufactures vertical boilers having capacities of from 440 to 5,500 lb hr and a great variety of pumps—centrifugal pumps for water, acids, soda or oil; also special pumps for marine purposes.

"Houttuin" screw displacement pump for non-lubricating and lubricating fluids.



Koninklijke Nederlandsche Grofsmederij N.V.

Chains, one of the special products of the *Koninklijke Nederlandsche Grofsmederij*, are not used solely in shipping. Chains for general usage, hauling chains, sling chains and transport chains are included in the production program. Wrought as well as welded chains are manufactured.

As its speciality, the K.N.G. manufactures the EGO chain. A few decades ago chains were made by the flame welding method in which factories remained limited to material with a maximum tensile strength of 40 kg mm^2. By using electric welding, steel of much higher strength could be utilized. This explains the particular advantages of the EGO chain, a welded stud link chain. Studs and links form one indestructible unit; greater strength of material makes possible a lighter weight and a smaller diameter while retaining equal strength. The "Spek" anchor is another speciality of the *Koninklijke Nederlandsche Grofsmederij*. It possesses many practical advantages: no jamming in the hawse hole, no rattling or knocking in rough seas, no damage to the hull through scraping of the flukes and greater holding power. As a result, this rodless bower has steadily gained in popularity.

Machinefabriek Hensen

The biggest shipbuilding crane in Europe stands in Holland; a product of one of the partners in NECOMA the *Machinefabriek Hansen* at Rotterdam.

The Netherlands has long been a country of harbor cranes. In the late Middle Ages and in the sixteenth and seventeenth centuries, when Holland sailed the seven seas, cranes were primarily used for the installation of ship's masts, a repair operation usually done at the home harbors. In this way the shore cranes came into being in Amsterdam and Rotterdam. One would seek in vain for this type of crane in such large numbers in other parts of the world.

Out of this centuries-old practical experience in the building of harbor cranes has come the technical knowledge which has made Hensen cranes a name in the modern world. Cranes for harbors and quays, cranes for shipbuilding and for ship repair work, level luffing cranes and jib cranes and all kinds of overhead cranes, cranes for every load and every purpose are the speciality of Hensen-Rotterdam.

N.V. Motorenfabriek Thomassen

There seem to be two special qualities in the economic atmosphere of the Netherlands which distinguish the Dutch from some other nations. On the one hand, the Netherlander is a born merchant who has greatly contributed to the growth of his country and its position in the world during the past few centuries, and on the other hand he has a definite urge to aim at perfection in production.

It is this last quality, perhaps, that has been particularly marked in Holland's industrial progress. It is this quality certainly, that has made the Thomassen Engine Factory one of the outstanding engine manufacturers in the country.

There is, however, another characteristic of the Dutch which is often to be seen in its industrial and commercial activities, namely, that of the traditional quality of never giving in, or never giving up. It is exemplified in the call of William the Silent, Founder of the Dutch nation, when he said: "*N'est besoin d'espérer, poser commencer ni de reussir pour persévér.*" This quality is to be seen not only in the never-ending battle against the water, even under almost hopeless odds, but also in the history of a firm like the Thomassen Engine Factory and its steady surmounting of all misfortunes and difficulties.

The personality behind the successful management and growth of this firm during three quarters of a century, a period in which it has taken a special place in the world of oil, was W.G.F. Thomassen, a born engineer with an unusual sense of mechanical design and an unerring aim at perfection.

However, there was more to its success than just the activity and enthusiasm of its founder, for among the other factors that turned a small blacksmith's workshop into a factory serving the world market is the way he was able to attract technical and scientific brains from among the best in the land. It was largely because of this policy, backed by inventiveness and dedication to perfection down to the smallest spare part, that Thomassen's attracted widespread attention as engineers of the highest quality.

Engines formed the foundation of the Thomassen production, beginning with the manufacture of gas engines before the end of the nineteenth century. A good machine-shop, however, can make almost anything, and so it was not surprising that in 1895 the firm made an automatic machine which served out tots of Dutch gin for the residents of the Home for Pensioned Colonial Soldiers!

Engines formed Thomassen's main activity in the last decades of the previous century, the very earliest days of the internal combustion engine. In those days the engines were fuelled by coal gas supplied by the municipal gasworks. As a result the company's stationary factory engine, then the most important part of engine production, was built as a gas engine.

Even in those early years the production of Thomassen gas engines was considerably higher than that of other types. The Thomassen gas engine ran smoothly without noise, and also used less gas than most of its owners had dared to hope. As the years passed, engines running on coal gas with a calorific value of 4,500 kcal per cubic meter gave place to engines running on suction gas at 1,100 kcal m^3 followed later by natural gas engines for gas with a calorific value of between 6,000 and 12,000 kcal m^3.

Many were the problems and difficulties that arose with the design and working of these early engines, but one by one they were overcome by Thomassen's engineers. Compressors were also built, driven by belting and then by direct-coupled motors.

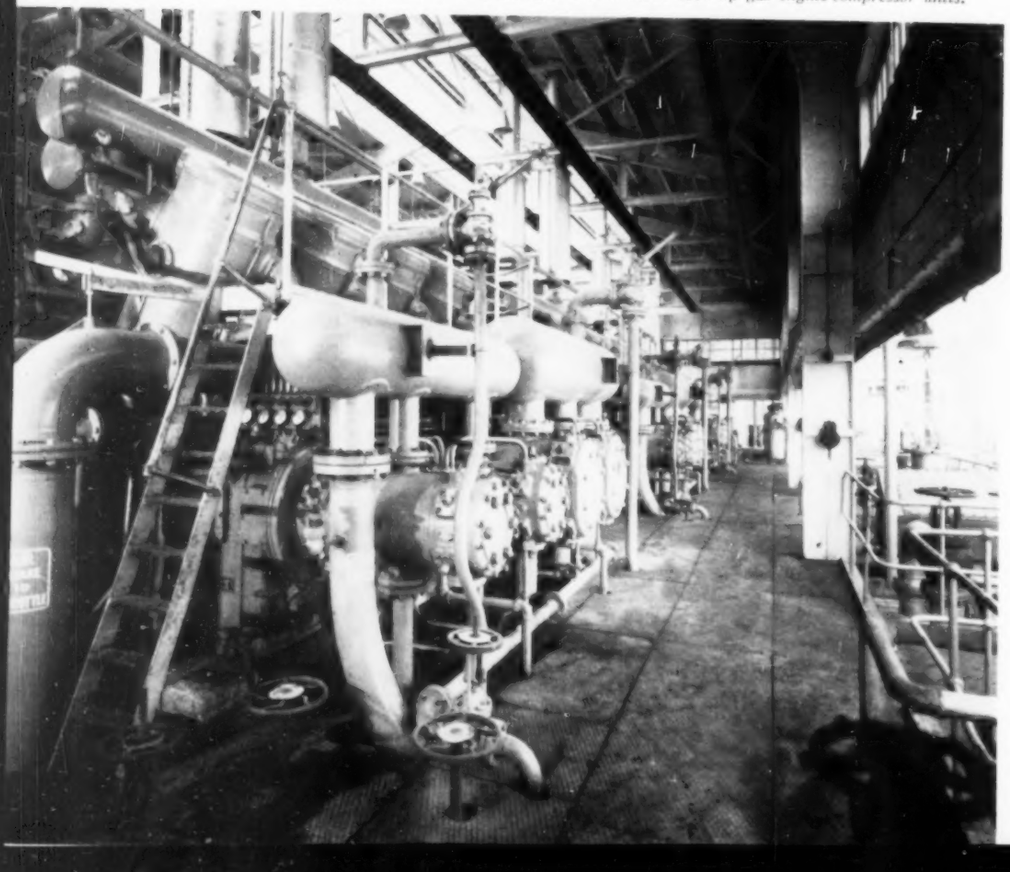
In more recent years, with closer relations with the oil industry, special quality diesel engines have been constructed of original design, and embodying a number of Thomassen's inventions. They include engines specially designed for drilling installations and other oil equipment. A wealth of experience is incorporated is these special diesels.

Half a century ago Thomassens was the first engineering works to use gauges accurate to thousandths of a millimeter, and it is this precision, still maintained and of course extended by modern techniques that marks the firm's production today. The resultant quality of Thomassen engines has been of inestimable value in the oil industry.

The gas engines manufactured grew in size from 2 hp to 4,000 hp. To these were added diesel motors, suction units and compressors and especially gas-engine compressor units. Thirty years ago the gas-engine compressor aggregate had a capacity of 180 hp and occupied an area of 70 square meters; today these installations have a capacity of up to 4,000 hp, yet occupy an area of only 50 square meters.

Other machines which now come from the Thomassen factory side by side with internal combustion engines and reciprocating compressors include pumping units, valves for storage tanks, deep well liner pumps, slotted steel oil well casing, wire-wrapped casing (license Emsco), centrifugal compressors (license Carrier), and gas turbines (license Westinghouse). In them all Thomassen quality and precision can be seen, maintaining the high reputation of the products of the Thomassen Motor Factory.

Partly shown in a refinery compresser plant are 8 Thomassen 1200 hp gas engine-compressor units.



Aerophoto K.L.M.

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Representative for U.S.A.:

A. Serton Inc., New York—20 N.Y., U.S.A.

Agents all over the world.

Our manufacturing program consists of:

Valves and fittings: gate, parallel slide and globe valves; check valves; water gauges; reducing and safety valves; combined cock and check feed valves for high pressures and high temperatures; cast steel and drop forged steel valves for the oil industry; valves for the nuclear industry; valves of corrosion resistant alloys; blow-off, filling and draining three-way cocks, and cocks for pressure gauges; thermostatic and float-steam traps; Peet valves; injectors, steam- and air-diaphragm whistles; unions for steam pipes; radiator unions and valves.

Castings: sand castings in bronze, aluminium, nickel and cobalt alloys and alloyed steel; precision- and die castings.

Our valves for the Petroleum Industry comply with the specifications of ASA and API. All castings are produced in our own foundries and the manufacturing is subject to a continuous quality control with the use of up to date methods.

We have established a name as producers of high quality valves and as such have supplied the requirements of many refineries throughout the Western as well as Eastern Hemisphere.

It is with pride that we feel justified to state that a very close and sound business relationship has been built up with most of the leading Oil Companies and Contracting Engineers.

During the course of the last five years we have been actively engaged in the development and manufacture of valves for nuclear purposes and as a result have supplied the valve requirements of a.o. the nuclear reactor projects of Kjeller (Norway) and Petten (Holland).

DIKKERS

Metallurgical and chemical laboratory

Our laboratory has the following departments:

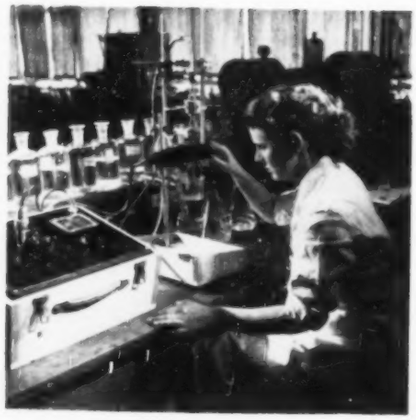
—Metallurgical Department
—Chemical Department
—Radiographical Department
—Foundry Sand Department

The metallurgical department controls all melting processes in our various foundries. All incoming materials are tested before being accepted. In the radiographical department all types of valves are regularly tested for soundness.

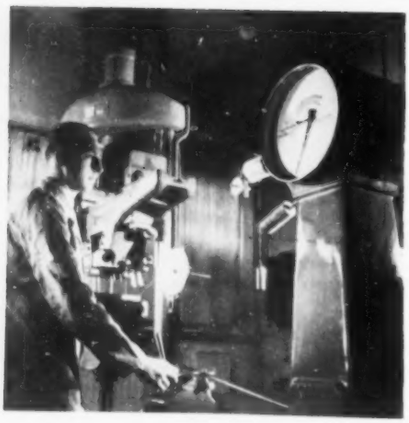
Certificates of testing are issued by the laboratory on request.

Our laboratory

Microhardness testing in the metallographic department. The hardness of various constituents in a specimen is measured.



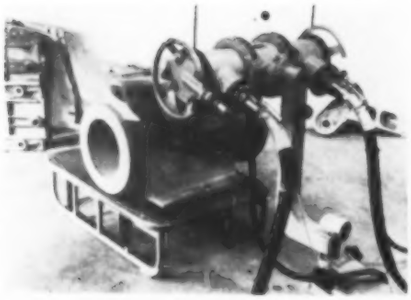
Potentiometric titration for exact determination of metals.



Determination of mechanical properties on a 50-ton hydraulic testing machine.

A metallurgical microscope is used for control and development.

The Radiographic laboratory.



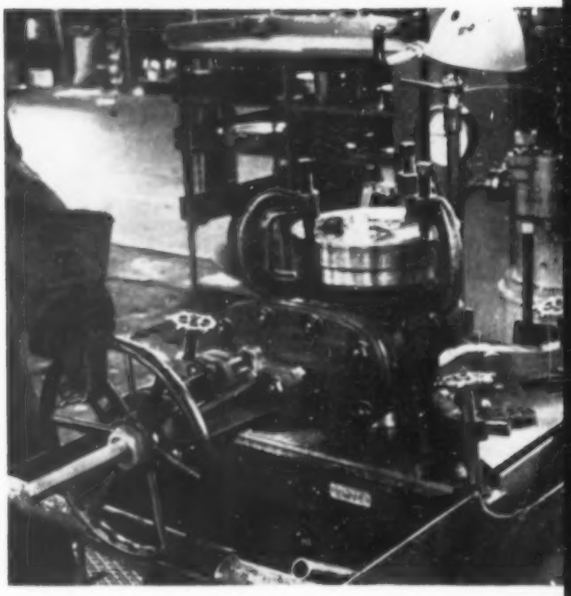
Radiographing an A.S.A. valve with a 300 kV. X-ray instrument.

Magnetic particle test. Our 2000 amp. instrument is an efficient tool for detection of the smallest tears and subsurface defects.

Series control of globe valves with a Cobalt-60 isotope for internal soundness testing.

Compressed air test on closed valve (just before immersion under water.)

Testing a valve for a nuclear reactor on pressure tightness.



Body test with kerosine (valve in fully open position.)

Bronswerk n.v.

They began with pipes . . .

Why is it that in many areas of the earth prehistoric handicrafts have been lost whilst elsewhere they have come down to us through the centuries? Why is it, for example, that although the artisans of Egypt 5,000 years ago could make exquisite gold-enamelled masks which even modern techniques cannot rival, no world industry has developed from it?

And how is it that the small country of the Netherlands has been able to establish an engineering industry which in this 20th century is an essential factor in the country's economic existence?

Behind these questions, and their answers, there lies a most interesting chapter in industrial history. As far as the Netherlands' engineering industry is concerned, many of its origins are both illuminating and important.

In 1867, for example, a firm was founded by Messrs Becht and Dyserinck in Amsterdam which concentrated on the casting of bronze, copper, zinc and iron. From the coppersmith's industry thus established there arose specialization in the designing, making and assembling of pipe systems on board ship.

The technique of working bronze had, in fact, been developed to a remarkable level some 3,000 years ago by the Frisian-Saxon inhabitants of the Netherlands. The decorated swords, armlets and bracelets, cast by a method that is now virtually a lost art, are still to be seen in Dutch museums and provide ample proof of great technical skill.

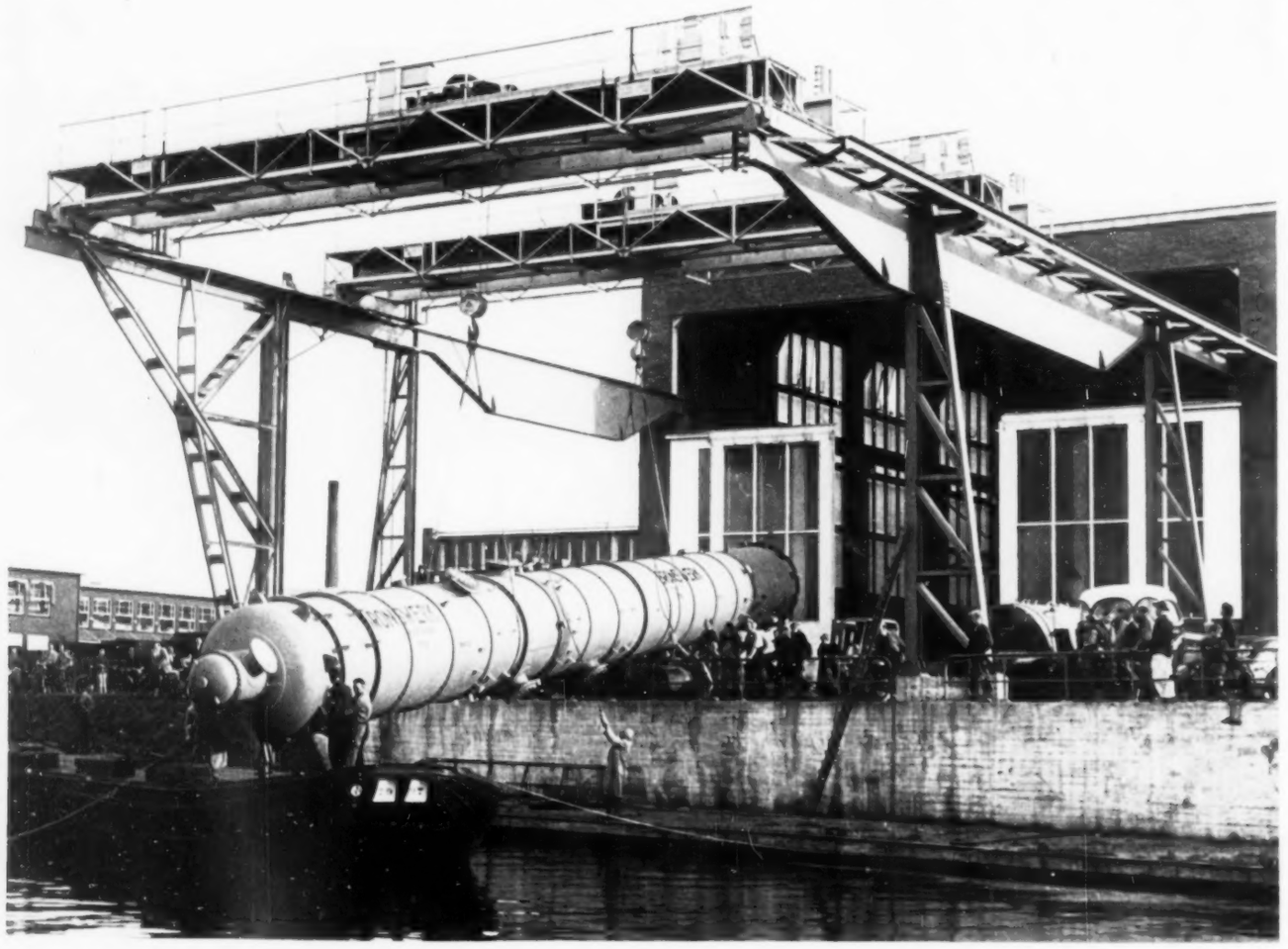
Throughout the ages, the people of the Low Countries have kept alive their special feeling for technical crafts. It is this skill which has gone a long way to create the successful industrialization of the Netherlands.

In 1947, to meet growing demands, there was a merger between the Amsterdam firm of Becht and Dyserinck and the engineering installation firm of Huygen and Wessel, which had been founded in Rotterdam in 1884. The new combination assumed the name of Bronswerk. In the design and construction of piping on ships, Bronswerk soon earned a name far beyond the Dutch borders and developed into a national industry.

The fabrication of pipe is not new to the Netherlands. In the 17th century a Dutch technician, Adam Silo, who was tutor to Peter the Great, received an order for the manufacture of pipe for a large French waterworks in Marly and in Fontainebleau, where the royal parks and gardens were enlivened with lovely fountains.

Again, the coppersmith and pipe worker has always been one of the most important artisans in Dutch shipbuilding yards. The old steamships required pipe for their steam, their cooling water and their lubrication. Gradually there arose a demand for pipe for fuel oil, whilst the coming of the diesel motor called for still more piping, much of which

The job has been done. Yet another fractionating column is skilfully maneuvered from the Bronswerk plant.



was bent into the most extraordinary shapes. This was work in which Bronswerk specialized and in which its skilled workmen excelled.

When in more recent times forced ventilation and air conditioning on ships came to be introduced and refrigerating techniques came into wider use, pipe systems became still more numerous and varied, so that with its great experience, especially in ships' installations, the first manufacturer of pipe in Holland became also the largest designer of heating, ventilating and air conditioning systems. The name of Bronswerk has become inseparably associated with such installations.

With the arrival of oil as a major source of energy, the significance of pipe became even greater. Once again Bronswerk was ready, and soon became one of the outstanding suppliers to the oil industry.

Parallel with these developments the Bronswerk factory started during the course of the present century, the design and construction of machines and heavy equipment for the oil and chemical industries. These included turbines and ventilators, heating and cooling elements, and boilers and pressure tanks.

The mechanization of industry and more recently the introduction of various automation techniques have resulted in great changes in the industrial scene. Once again Bronswerk was ready for the new situation.

The rapid progress and preparedness of Bronswerk is not merely the result of happy chance. Throughout the firm's history both foresight and enterprise have been constantly present. Many years ago, for example, the machine works of Voorwaarts in Amsterdam had been established by the large shipyards as a control or checking center for orders placed with different firms. Development work in the field of cooling techniques led to cooperation between this enterprise and Bronswerk. This form of coordinated production went a step further through the establishment of the N.V. Plaatwellerij, a plate-working industry close to the Netherlands Blast Furnaces and Steel Industry at IJmuiden by the mouth of the North Sea canal leading to Amsterdam Harbor. It has one of the largest and most modern plate rolling mills in Europe.

The Bronswerk N.V. group, with over 2,500 workers, and with its headquarters and large factory complex in Amersfoort, has become one of the Dutch industrial enterprises playing an ever-growing role in the world market. With its special heating and ventilation departments, it is also one of the largest heating equipment manufacturers in Europe, with special experience in the field of large industrial heating, ventilating and air conditioning installations, of which the most important components such as boilers, ventilators, air coolers, air heaters, heat exchangers and air filters are all made in their own factories.

Complicated, heavy-guage piping is a specialty of "N.V. Bronswerk."

Among the range of turbines and fans is the Bronswerk Marquardt turbine developed by the firm itself. Many of the fans are also largely the result of the firm's own development and research and are so designed as to have a maximum output with almost noiseless operation.

The cooling and heating elements, as well as the specially constructed heat exchangers, are made on a fully automatic system. And in addition to the complete air heating and air conditioning installations turned out, Bronswerk also makes the many component and spare parts for such systems, for the supply of which it has its own representatives in Belgium, Germany, Spain and South America.

So the list could be continued. Reactor vessels, pressure tanks, fractionating towers, water boilers and fire tube boilers of great size find their way from Amersfoort or Velsen all over the world. And if certain associated products are outside Bronswerk's own sphere of research or experience, agreements are made with foreign industrial enterprieses, especially in the dollar area, for the manufacture under license of those articles which will fit into Bronswerk's own production program.

The traditional qualities of the Dutch workman, his technical skill and initiative, backed by centuries of experience in international trade, commerce and finance, and supported by a sound government economic policy ensuring low production costs, have enabled a firm like Bronswerk N.V. to enter the world market and add to the good name of industrial Holland throughout the world.

Machinefabriek Reineveld N.V.

A mansion built during the late Middle Ages in the old market town of Delft, became the birth-place of the *Machinefabriek Reineveld N.V.*

In the year 1841 the Delft smithy, Hartogh Heys, began manufacturing files aided by a steam engine. A machine workshop grew out of the file works, an iron foundry was added and, in 1891, with the active collaboration of three large undertakings (*De Nederlandsche Gist- en Spiritusfabriek*, the *Oliefabriek Delft* and Stork & Co. at Hengelo) a really "big industry" was started in the old mansion of Reineveld.

From that moment the Reineveld machine works followed the principle that a place for the Netherlands engineering industry could only be gained in the world when it did not manufacture those products already made by other undertakings, but specialized in certain fields only. In keeping with this idea, Reineveld was one of the first, and few, Dutch workshops in which the principle of specialization formed the cornerstone of its production program. Before the start of the twentieth century, Reineveld began with the manufacture of pumps, like so many other Dutch engineering works. Reineveld was an early believer in the value of scientific research. The technical advice of one of the professors of the Technical High School at Delft led to the development of the Reineveld-Java pump which assumed great importance in the plantations of the Dutch East Indies.

The development of laundries in Holland opened up new activities for Reineveld. The Dutch housewife has been known since olden times for her cleanliness; for centuries laundries had existed in the vicinity of almost every city; later on, steam laundries came on the scene. At the beginning of the twentieth century Reineveld's contacts with a number of laundries led to the manufacture of washing machines—machines of diverse types; these still occupy an important place on the production program. Steam laundries require soft and clean water. The Reineveld works had devoted considerable effort to the design and manufacture of water purification plants. From a small beginning, Reineveld entered into the whole water purification field. In addition to machines for the laundry industry, centrifuges are also manufactured.

Reineveld has developed and perfected various foundry techniques. In this case also, the principle of specialization was applied. Attempts to improve the wear resistance of cast iron led to the manufacture of perlitic cast iron. A pure perlitic structure is desirable for sliding as well as for rolling wear: Reineveld produces pure perlitic V.D.S. cast iron. In order to increase the corrosion resistance of cast iron (which is already higher than that of steel) the iron is alloyed with nickel and chromium highly alloyed V.D.S. cast iron types are rust free when polished. In addition to this, a new development which is coming to the fore is the manufacture of spheroidal graphitic cast iron according to a patented system.

At present, however, the manufacture of this special cast iron is only part of Reineveld's production. Except for the manufacture of washing machines, the main production consists of centrifuges for the chemical, food stuffs and coal industries, and water treatment plants; two specialities of great importance to the world oil industry.

Forty-five years ago Reineveld delivered the first centrifuge for use outside the field of laundry work. Since then the production has developed to supply the needs of numerous branches of industry. Thirty years ago, Reineveld introduced the continuous type of centrifuge into the coal industry—this, the famous "Drying Dutchman," has obtained a place of its own in the world over the years. Besides the wholly automatic horizontal types and the non-automatic non-continuous types, the firm manufactures the "Centriplane" continuous centrifuge for the chemical industry; it is of particular importance for automatically controlled plants.

In the manufacture of the numerous special types of centrifuge use is made of the most modern techniques—from electronic balances to the latest foundry methods and the most recently developed kinds of material. The advantage of centrifuges over thermal drying is that it is cheaper owing to the high cost of thermal energy compared with the cost of removing moisture by means of centrifugal action.

Last, but not least, there is the water purification equipment—a field in which Reineveld is a specialist par excellence. There are Tymoor water purifiers for filter processes and coagulation; ion exchangers, degassers, equipment for removal of iron and manganese, chemical purifiers, lime, soda or phosphate softeners, Tymoor silt separators for the draining of silt formed in the boiler during softening by the entry of phosphate into the boiler, and, in the last place, devices for injection of extremely accurate dosages of solutions. These devices are of general application in the oil industry, for example, for the preparation of boiler feed water for low, high and very high pressure boilers, the de-oiling of condensate, the preparation of drinking water and various other purposes.

The technical experience of more than a hundred years, the accuracy of Dutch craftsmanship and the knowledge of modern science have all been embodied in these Reineveld machines and apparatus. Reineveld owes its name and its sales all over the world to these outstanding qualities.

Centrifuges for the petrochemical industry

Treatment of slurries containing:

- Diphenol-propane
- Polyvinylchloride
- Polyethylene
- Salt glycerine
- Acrilate polymer

Water-Treatment plants

For the preparation of feedwater for low-, high- and very high pressure boilers; de-oiling of condensate etc.

General view of an oil storage tank site.

BRAAT — Construction workshop and machine factory

Half a century ago the Netherlands had no more than about 5,000,000 inhabitants. Of these just over 10% worked in agriculture, with about the same number engaged in industry.

Although small, Holland had a large field of operation and a market potential in its extensive possessions in the Indonesian Archipelago. These provided the growing industrial activity of Holland with much greater opportunities than it could expect from Netherlands territory alone.

Even in 1909, therefore, when the Braat Construction Workshops and Machine Factory was established in Rotterdam, Holland was already an economic entity of international status. The industrial and organizing experience which Netherlanders obtained in their own overseas territories and in many other countries developed forces and capacities which in recent years have been of the greatest significance for the industrialization of such a small country.

In connection with construction work, moreover, there was another important factor; the centuries old participation of the Dutch traders in all forms of transport. For only where there exists the best and most modern means of transport can there be developed a construction engineering firm working for the world market.

For Braat of Rotterdam, indeed, the transport factor was of the utmost significance in its origin and development. On the island of Java in the Dutch East Indies the Braat Machine Factory had been established which found a market for its construction work and machines in the various plantations spread over the whole of the Indonesian Archipelago.

With the growing size of the equipment and installations manufactured it was found that transport costs were a most vital factor. It was even found that the transport of heavy equipment such as machines and storage tanks was less costly from Rotterdam to the so-called Outer Possessions (islands other than Java) than from Java to the plantations on these islands.

For these reasons it was decided 50 years ago to establish the heavy engineering works in the Netherlands. Since that time Braat of Rotterdam has been building structures of special design for the overseas territories and for plantations and other customers all over the world.

The making of tanks for the storage of molasses in the East Indies sugar factories led to the manufacture of special tanks for other purposes, such as first tanks for oil storage and later for gas. From that new line of work there emerged another specialty: the enlarging of existing storage tanks. The most economical method of increasing the storage capacity of any established tank farm is to increase the size of the existing tanks. To enable this to be done Braat developed its own special method by which a new wall was added to the bottom of the existing tank in such a way as to considerably enlarge the tank's capacity.

With gas promising to play a more and more important role in the petrochemical industry, it is clear that the gas tank is also gaining in economic importance. In theory the ball-shaped tank is the ideal form for this sort of storage. But there were difficulties. However, Braat overcame the fabrication obstacles which presented themselves and constructed a spherical butane tank of 1,000 cubic meters capacity for a working pressure of 7.6 atmospheres or 117 lbs per square inch. Built according to API ASME codes, all welded seams are 100% checked and tested by X-ray radiography. It is worth noting here that as the American regulations require considerably heavier construction than are demanded by the Dutch law this tank is approved in the Netherlands for a working pressure of up to 13 atmospheres.

Under certain circumstances underground tanks can offer special advantages. But when an extra cellar construction is to be avoided, it is necessary to make special reinforcements around the tank to retain a manageable weight of sufficient strength. This of course raises difficulties, but Braat succeeded in designing a special form of construction for these too.

Braat's production is not limited to the making of tanks. In addition, the factory supplies piping installations for complete tank farms. Again, its very old relations with the Netherlands coal mines led to the construction of a number of special transport installations which repeatedly called for new ideas to solve new problems. From the experience gained in this form of equipment Braat developed transport installations and the various equipment now required by the petrochemical industry.

Braat supplied storage tanks as well as pipe in this installation addition.

Braat Construction workshop and machine factory.

At all times and with all projects carried out by Braat two factors play an important part:

In the first place, the establishment of the factory in Rotterdam, where the most modern harbor equipment enables even the heaviest and most cumbersome machinery to be put on board ocean going vessels quickly and comparatively easily.

In the second place, Braat remains "a specialist in the specialized." Almost all installations and equipment produced by Braat are not to be found among the products of the average engineering works. They are individual pieces of equipment whose manufacture is possible only with the technical inventiveness and 50 years experience of this well-established firm.

Reed Roller Bit Company

In Holland, an ideal location

Tegay the skills of Dutch craftsmen using the latest techniques and ultra-modern machines are turning out rock bits for the drilling areas of free Europe, Africa, South America, and the Near and Far East.

This demanding work is being performed in the modern, completely equipped plant of Reed Roller Bit Company (Nederland) N.V., at Roosevelt Straat 6, Leiden.

Reed N.V. is the European subsidiary of one of the oldest and largest drilling tool manufacturing firms in the world.

This plant has been envisaged as a large supplier of Reed Rock Bits to markets outside the United States. Though in operation less than two years and still building toward its programmed employee strength and production capacity, the plant is steadily approaching its ultimate goal.

It was on August 20, 1957 that Reed N.V. officially opened in the new industrial area of Leiden. On that occasion Dr. E. L. Kramer, Director General for Industrialization and Power Supply of the Netherlands Ministry of Economic Affairs, honored Reed N.V. with an address in which he pointed out that the new plant stood to materially benefit the Netherlands by enhancing her position as an exporter of industrial products.

A seat of world leadership in all phases of the petroleum industry, the Netherlands offered compelling advantages which contributed to the establishment of the Reed plan on Dutch soil. In no other country could a more ideal combination of favorable factors be found:

A plentiful labor force of traditional skill and vigor. An ideal location for serving the markets of Europe and the East. The many economic advantages of inclusion in the European Common Market. Unexcelled airlines, railways, inland waterways, and deep-water shipping facilities.

Convenient access to the raw material needed to build quality rock bits—high-grade steels quickly available from the mills of Western Europe.

The availability of superb modern machinery from the factories of practically every country of Western Europe. Machines of both conventional and highly specialized design are employed for the precise machining techniques necessary to produce rock bits of the highest quality.

Built to Reed's own specifications, the Reed N.V. plant was executed in modern functional style by the Aannemings-Maatschappij "Panagro" N.V. at Warmond, with cooperation from Architect Jean Bodt at Oestgeest. The buildings have been commissioned by the Municipality of Leiden.

The factory has a cork-insulated roof constructed of reinforced corrugated concrete slabs laid in supporting girders of prestressed concrete. The girders themselves rest on three columns and are prestressed with cables according to the Freyssinet system. Maximum prestressing force amounts to about 100 tons.

Only six columns stand in the hall on a surface of 2,111 square meters. The foundation of the building consists of concrete piles with a maximum bearing power of 20 tons.

To Reed N.V. the parent company, Reed Roller Bit Company of Houston, Texas, U.S.A., has brought over 40 years of experience and accumulated technology in the design and manufacture of bits for rotary drilling. Today's Reed Y Bits, in jet and regular types and in many distinct "formation-engineered" series, are now produced in quantity in the plant of Reed N.V. in Leiden and marketed through sales outlets in fifteen nations. These bits have been proven in every formation in every drilling area of the free world.

Netherlands Dock and Shipbuilding Company, Amsterdam.

Builders of heavy equipment for the oil industry

The construction and transportation of "heavy pieces" is one of the essential operations in shipbuilding. The experience gained in the construction of very heavy ship sections and the technical equipment required for this purpose were the main factors which led to the Netherlands Dock and Shipbuilding Company, Amsterdam's oldest and largest shipbuilding and drydock company undertaking the construction of heavy equipment for the oil industry.

In recent years the N.D.S.M. has applied itself especially to the building and repair of oil tankers. The largest berth has a capacity of 72,000 dwt.; in addition there are four graving docks, the largest of which has a length of 800' suitable for the accommodation of tankers up to about 70,000 dwt.

Since 1946 the N.D.S.M. has also been building ship's engines and turbines; NDSM Stork diesel motors, NDSM Doxford and NDSM Götaverken-diesel motors. The firm is, moreover, a licensee of Parsons & Pametrada for turbines, of Babcock & Wilcox and Foster Wheeler for boilers and of Westinghouse for turbo-generators.

For the gas freeing and cleaning of tankers the N.D.S.M. has an installation situated on the extreme West of the extensive yard and dock premises. This installation ranks among the most modern and best equipped plants in the world and plays an important role in tanker repairs.

As it is no longer allowed to pump oil remnants overboard within 100 miles from the coast, tankships can now be quickly and efficiently cleaned and made completely gas free in the port of Amsterdam. The ballast water of these ships, which can be pumped ashore at a rate of 1200 tons per hour, is separated from the oil in an API (American Petroleum Institute) separator. This is a concrete reservoir (length 80 meters and width 10 meters) in which the oil is allowed to rise to the surface of the water to be skimmed off at the end of the separator. By means of six tank washing machines the walls of the tanks are then washed, whilst ejectors and fans free the tanks of gas.

During the gas purging and cleaning, repairs not involving open flames in the engine room, can be begun. The possibility of doing this preparatory repair work during the cleaning reduces the stay of the vessel at the yard to a minimum.

Equipment for the oil industry

The great capacity of its boiler shop and the large cranes and machine tools available induced the N.D.S.M., builder of tankers, warships and passenger liners, to develop the construction of equipment for the oil industry.

The largest circle plate bending roll has a maximum width of 23'-0" for $1\frac{1}{2}$" plate thickness. A 1000-ton hydraulic gap-type press for hot and cold bending is available. In a gas fired furnace, plates can be heated for stress relieving up to 1100° C.

For the petroleum industry the N.D.S.M. builds heat exchangers, condensers and refinery columns with diameters up to about 20'-0" and with a plate thicknesses up to $2\frac{1}{2}$". Dished ends and conical parts are built up from segments which are hot pressed in dies. Large spheres for butane and propane storage with diameters of 40'-0" have been mounted, welded and fitted in the N.D.S.M. boiler shop.

Reactor vessels for cracking installations have been made. These are prepared in two parts; top and bottom, each weighing about 100 tons. Made entirely of clad steel, these huge parts were carried as deck cargo to the country of destination.

A stabilizer tower with a weight of 160 tons, wholly completed in the shop, will be transported in the same way to a refinery. This tower, with a length of 151', is one of the biggest objects ever made by the N.D.S.M. for the oil industry.

With its origins in the ancient Amsterdam craft of shipbuilding, the first and largest shipbuilders of Holland, the Netherlands Dock and Shipbuilding Company, has grown to one of the greatest metal working and engineering industries. Specializing in the construction and repairs of tankships for Dutch and foreign owners, she has become also a specialist in the construction of heavy equipment for the world oil industry.

D. Drukker and Sons, Amsterdam

Speaking about diamonds

The diamond trade and the diamond-working industry are based on two important essentials: experience and specialization.

That the largest stones in the British Royal Crowns were cut and polished in Amsterdam, and that Amsterdam traditionally provides the entire world with both ornamental and industrial diamonds, is the direct result of her long experience.

Annually about 20,000,000 carats of diamonds come on the world market, of which 16,000,000 carats are used for industrial purposes. But of these only some 1,000,000 to 2,000,000 carats are suitable for the manufacture of rock-boring drills.

Two factors determine the practical value of a diamond for boring crowns: the carefulness with which it is selected and the skill in placing it in the drill assembly.

As with every form of practical engineering the manufacture of diamond drills demands the most favorable relationship between quality and cost. It is no special achievement to use the largest, strongest diamonds; but it requires a specialized knowledge and experience to choose those stones which give the highest technical satisfaction at the lowest market price. This experience, based on both cutting and polishing, has been long in the hands of the old established Amsterdam firm of D. Drukker and Sons.

The cutter of the ornamental diamond must always find the natural cleavage surface of the stone before he starts his work, and it is only experience that can solve that problem for him. But the same experience is needed to select the industrial diamond in such a way that the chances of breakage are reduced to a minimum.

Diamonds can only be properly polished along certain crystallographic planes, and these are the very surfaces on which the wear is the greatest, when the stone is used in a boring head. Once again it comes back to the factor of experience on the part of the polisher when determining the correct orientation in which the diamond should be mounted in the bit.

Drukker selects industrial diamonds for drilling material from 200 per carat stones, as only in that way is it possible to ensure the right selection of material for every type of drill and for every method of drilling. The rougher stones are used for soft and medium-hard formations; the finer sorts are for hard and very hard formations.

Because of its long acquaintance with this unusual industrial material, the diamond, Messrs. Drukker were led to originate and develop a special core barrel for soft formations. This is a core drill of the wire line type by means of which the core can be drawn out without touching it by hand before it reaches the laboratory. This drill is now being used with great success in most of the great hydraulic projects undertaken by the Netherlands in many countries.

The port of Amsterdam

The Sea and Rhine port of Amsterdam owes its illustrious past, its thriving present and its future potential, to its location. It is situated on a tributary of the Rhine, the main artery of European traffic, which since Roman times has been the gateway of Western European sea-going traffic and Western European trade.

In front of the city of Amsterdam stretched a wide inlet of the old Zuyder Zee—which had an open connection with the North Sea—offering a particularly safe roadstead for shipping. Numerous waterways connected this harbor area with the Rhine and with the economically important European hinterland.

During the second half of the past century, Amsterdam acquired a more direct connection with the North Sea; by means of the North Sea Canal, the harbor of Amsterdam was linked to the Dutch sea coast along the shortest route.

Access to this canal is gained through a lock complex, of which the north lock with a length of 1312 ft., a width of 165 ft., and a depth on sill of 50 ft., is the largest in the world. Recently the inland waterways from Amsterdam to the Rhine have been improved in various ways, and in 1952 a new up to date spacious waterway, the Amsterdam-Rhine canal was opened. From that moment, the Rhine trade to and from Amsterdam has shown a continual and rapid increase.

The harbor and waterfront of Amsterdam constitutes one large dock-harbor area; the lock gates at IJmuiden protect it from the tidal influences of the sea. The southern gateway to this dock harbor area is formed by Europe's largest lock for inland navigation, where the Amsterdam-Rhine canal meets the river Rhine.

Owing to this Amsterdam-Rhine canal Amsterdam can boast a shorter route to the German, French and Swiss Rhine ports, than any other Western European seaport. This means that Rhine traders need less time to reach the seaport of Amsterdam from the large European inland river ports. Moreover it means that Rhine boats, after loading at Amsterdam, sail inland part of the way along a stream-free canal instead of along an open river, which means a considerable reduction in fuel-oil expense. Since it is also possible to proceed along the canal at night, this not being the case on the river, this waterway from Amsterdam offers many decided advantages. It is not surprising, therefore, that a constantly increasing share of Rhine trade is making its way via Amsterdam.

The port of Amsterdam expanded rapidly during the 17th century because it served one of the most prominent trade centers of that day. Then as now, Amsterdam was an important general cargo port. Amsterdam can thus boast of a centuries old experience and know-how when it comes to handling general cargo, tropical produce and industrial products, as well as the distribution and transit of these commodities to the European hinterland.

Amsterdam is one of the largest timber ports of the European continent. This trade, dating back to olden times when timber was imported here for shipbuilding purposes, has been maintained until the present day, to supply the Netherlands and Western Europe with hard and soft wood.

In the last 4 or 5 years Amsterdam has become of importance as a port for transshipments of large consignments of bulk commodities. This is partly due to the export of coke from the Dutch Staatsmijnen and of salt from the Dutch salt industry; products that are widely distributed across the world.

More important however is the fact that Amsterdam is a port through which a large share of Central Europe's needs for important raw materials such as coal, oil and ore, are imported. The area where the heavy industry of Europe is largely concentrated is situated near the lower and central Rhinelands; here lies also the heavily industrialized German Ruhr area. It is only a short while ago that the German coal mines used to export coal; now the demand for this fuel has increased to such an extent, that large quantities of coal must be imported; the fact that there is a surplus of coal at the moment, is merely a temporary phenomenon.

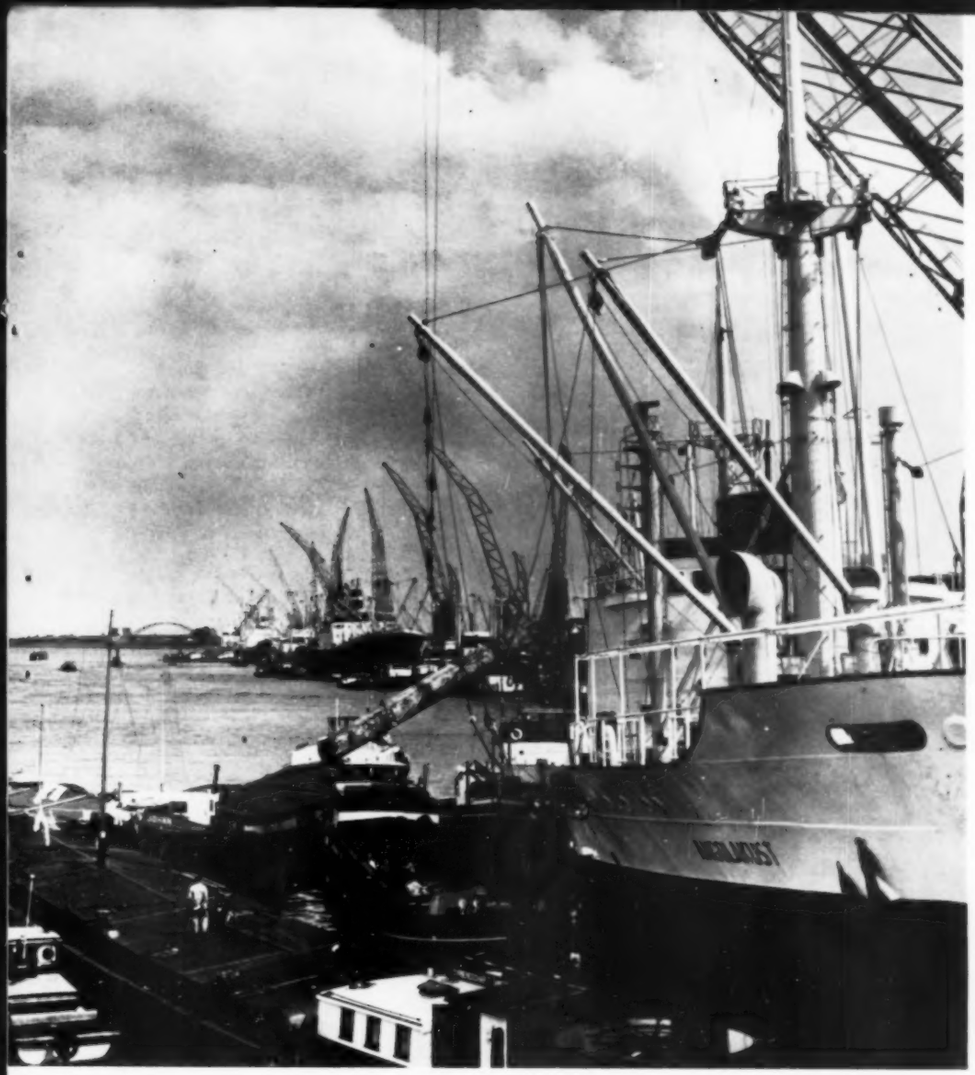
The sharp increase in trans-shipments of ore, coal and oil in the port of Amsterdam is the direct result of three factors. In the first place, there is the general rise in demand for these bulk commodities in Western Europe. The second factor is the excellent connection of the port of Amsterdam with the Rhinelands via the new Amsterdam-Rhine canal. In the third place, Amsterdam's trade and industry were not found wanting when, in a very short space of time, facilities had to be provided for the rapid transshipment and storage of bulk commodities: Shoreside installations of ample capacity were constructed and an enormous storage potential was established.

It goes without saying that the particular advantages of a dock harbor with no tides to cause the ship to rise and fall alongside the quay has played an important part in all these developments. Moreover, in the harbor-basins deep water is found right up to the quay walls, so that ships need not discharge in the stream, but are loaded or discharged alongside wharfs or quays. Because of all this, the modern dock basins in the port of Amsterdam are among the most up to date in the world.

Amsterdam an oilport

Facilities for the storage of oil at Amsterdam include the largest free depot for oil storage in bond in Europe. It is to say, Amsterdam is the largest mercantile port for oil products. Three hundred years ago, when the possibility of an oil industry was remote, Amsterdam was importing crude oil from northern Sumatra, carried in specially designed Siamese earthenware containers. The oil was used in those days for medicinal purposes. In the beginning of the 17th century especially in Italy, paraffin was used as a remedy against ailments. The paraffin

General view of an oil storage tank site.



AMSTERDAM Harbor has a very special place in the chain of North Sea ports which are the gateways to the highly-developed industrial area of Western Europe.

In the harbor and docks of Amsterdam the largest vessels can maneuver and berth without regard to either the flood or ebb tides and unhampered by currents.

Amsterdam Harbor is situated at a shorter distance from the central European inland Rhine harbors than any other ocean port in Europe.

Amsterdam is now expanding its harbor area by no less than 3,750 acres. This expansion plan makes special provision for the trans-shipment and storage of oil, coal and ore.

The North Sea Canal, which provides access for ships from the North Sea to the docks of Amsterdam, can take vessels of more than 70,000 tons. In a later stage the canal will be able to take tankers of up to 100,000 tons.

Amsterdam was receiving crude oil from Sumatra as early as 1637, and it is certain that this oldest of all the European oil ports will in the future continue to hold its honored place in the oil supply for a more and more industrialized and united Europe.

Burgomaster of Amsterdam

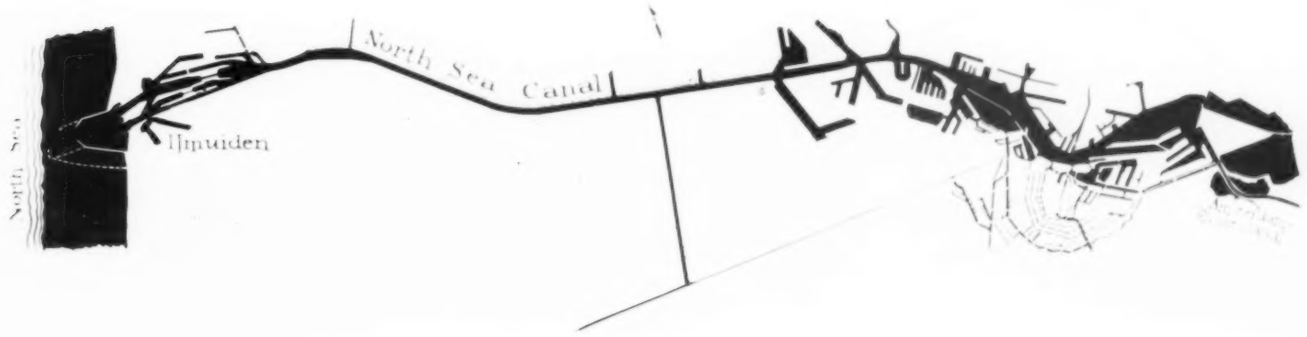
from northern Sumatra, imported at Amsterdam gained quite a reputation in this field and was much preferred to the home-produced article.

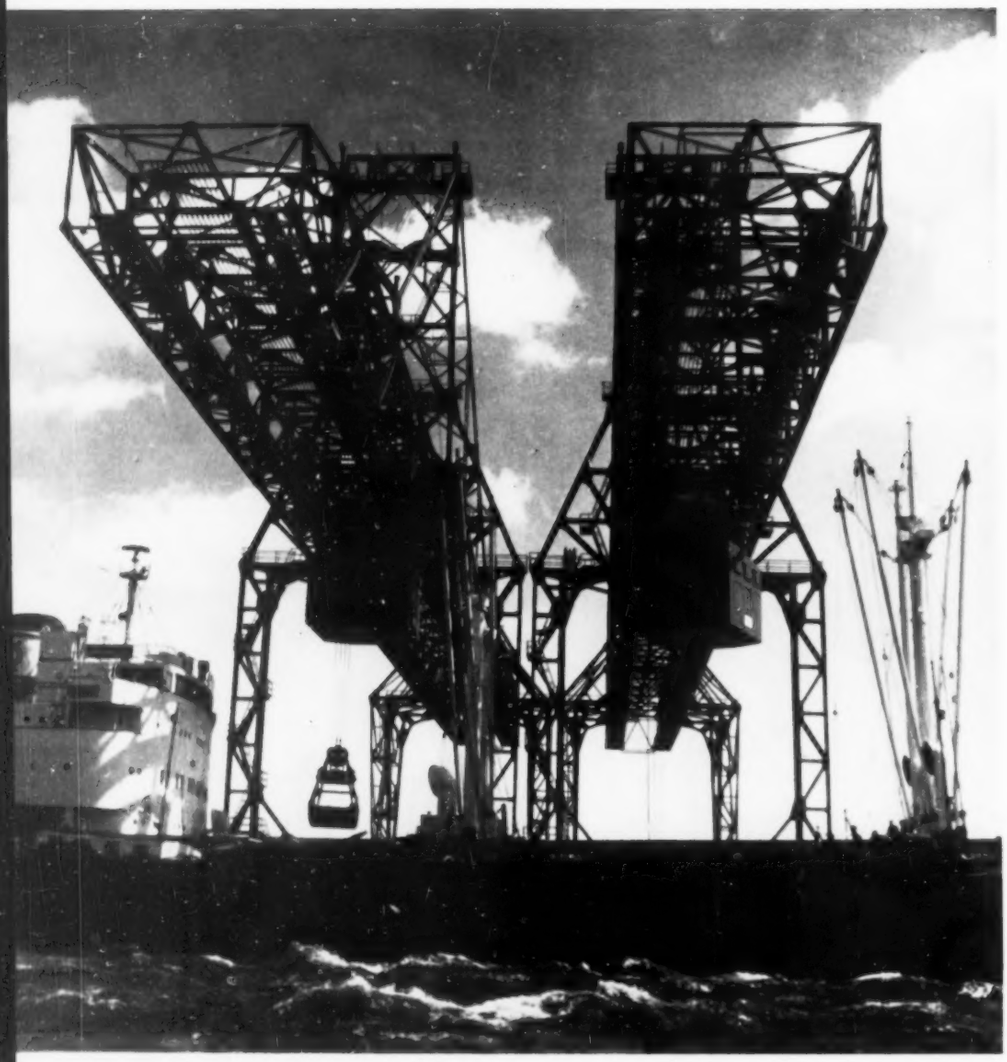
Now, three hundred years later, Amsterdam is a large oil storage and shipping port in her own right. Free tank storage capacity now exceeds 700,000 cubic meters which is more than any other European seaport can claim to offer. (Private storage capacity of the large refineries is here left out of consideration). Because of this Amsterdam plays an important part where imports of oil derivatives for Europe are concerned.

Amsterdam is the oldest oil port in the world and the future still looks very promising. For the future oil position of Europe it must be borne in mind that by 1975 a rise in the consumption of oil in Europe to 340 million tons is expected, i.e. some 200 million tons of crude more than was used in 1957. The total capacity of the European refineries, which last year amounted to 134 million tons, is expected to rise to 206 million tons by 1962 and an even greater capacity by 1975.

The transportation problem is being tackled with the help of three large pipelines for crude oil, which are being laid in Europe: one from Wilhelmshafen to the German Ruhr area; one from Rotterdam also to the Ruhr and one from Marseilles, which will eventually also connect to the German industrial area. The total capacity of these pipelines will amount to 27 million tons for the Wilhelmshafen and Rotterdam pipelines combined, plus another 10 million tons for the Marseilles pipeline. Although this capacity is thought to be sufficient for supplying the German and eastern French refineries, other shipping will continue to claim its share of the transport of crude oil and finished products to the various seaports. Two or

Amsterdam Sea- and Rhineports.





three million tons of crude oil will have to be shipped to supply oil refineries not linked to the pipeline system. Moreover, in view of the widely varied demand for finished oil products, import of crude and export of finished products will remain necessary, particularly with an eye to the Scandinavian market. Since Amsterdam is favorably situated with regard to Scandinavian trade, it may safely be assumed that the port will be called upon to play a leading role in this development.

A further point is that because of the unbalanced distribution of the various oil products expansion of existing refining capacity in the European ports will become necessary. When the time comes, Amsterdam has sites and equipment available to execute the plans that are presently afoot for expanding these port refinery facilities.

A question that is of growing importance is the suitability of the various western European ports to accommodate supertankers of 40,000, 65,000 or even 100,000 tons. Amsterdam is fortunate in this respect, for the North Sea outside the IJmuiden approach to Amsterdam, has a minimum depth of 40 ft, enabling the largest of ships to enter. Already preliminary measures have been taken to render the outer harbor of IJmuiden accessible to ships of 75,000 tons at all times and to ships of 100,000 tons at high tide. After passing the large lock at IJmuiden, which can accommodate ships of 100,000 tons, these supertankers, without hindrance from tidal influences, can proceed along a widened North Sea canal, to reach the port of Amsterdam.

Concurrently with the above developments, Amsterdam has plans afoot to increase its harbor area by 3,750 acres, which means a 100% increase on its present size. Part of this expansion is to enlarge general cargo facilities by constructing harbor basins, quays and cargo-sheds. An extensive area is earmarked for trans-shipment and storage of bulk commodities, among which oil acreage will have an important place. Furthermore space is being created for new industrial plants, for example refinery installations and petrochemical plants.

During the next 10 years, oil will become of increasing importance to Europe to keep the wheels of industry turning. The port of Amsterdam has been preparing to play a prominent part in these expansive times. Amsterdam is well qualified to fill such a role, with the particular facilities she is able to offer backed-up by the energy and drive of her industrial leaders and the foresight of her port authorities.

Holland's chemical industry

The chemical industry has shown a phenomenal growth throughout the world in the past fifty years. The Netherlands did not stand still in this progress, although at the beginning of the present century Holland could hardly stand comparison in this field with the powerful industrial groups abroad. To-day Holland has a flourishing chemical industry which, by directing itself particularly to the most modern processes, takes third place on the list of important Dutch industries, behind engineering and agriculture. Moreover, whilst the latter is of especial significance for the home market, the chemical industry exports about one half of its production abroad.

Rapid progress has been made in the present century. The growth of a petrochemical industry, and of an organic chemicals industry and the finding of rich salt layers and important oil fields in Holland during the past two or three decades, all these have contributed to the development in the Netherlands of a strong chemical industry, which has special affinities with the petroleum industry.

The Royal Netherlands Salt Industry started in the eastern part of the country with the exploitation of rich salt domes and the production of various chemicals from salt. One of its products is sodium lye, used for the manufacture of catalysts for the petroleum industry by Ketjen. The chlorine thus obtained is transported to the oil refineries near Rotterdam where it is used in the petrochemical industry. Salt is the raw material for the large soda factory at Delfzijl.

Still another stream of chemical activity flows to the sulfuric acid factories of Ketjen where the sulfur extracted from oil by the petrochemical industry is used as the basis for making sulfuric acid, again an important chemical for the oil refining industry.

The old mining industry in the southern part of the Netherlands has gradually grown into a very specialized chemical industry. The coal layers formed by Nature throughout millions of years, and natural oil reservoirs are two of the richest raw materials for the manufacture of many valuable chemicals and derivatives. The coke production of the Dutch mines is the basis of the great steel industry on the North Sea coast near IJmuiden. Both at the mines and at IJmuiden coke gases supply the hydrogen for factories producing nitrogen-containing artificial fertilizers. At the IJmuiden installation this process is carried out by a special firm, Mekog, in which the Netherlands oil companies also have interests. This was the first petrochemical undertaking in Holland by the Royal Dutch Shell group.

The Dutch State Mines are now producing more and more by-products and derivatives from coal, including raw materials based on benzene for the plastics industries, solvents, and raw materials for the lacquer and paint industries.

The basis for a great part of the synthetic fiber production of the Netherlands A.K.U. factories, world wide rayon manufacturers, comes from the coal derivatives of the State Mines. The rapidly growing plastics industries in Holland are largely based on the heavy chemicals manufactured by the State Mines and the petrochemical industry at Pernis near Rotterdam.

The centuries-old Dutch soap manufacture has been widened to include the production of detergents; the paint industry, fostered partly by the demands for paint in a moist climate, found an even greater stimulus and importance in more recent years through the growth of the Netherlands shipbuilding industry. The perfume and essence industries, in keeping with modern progress, have also become of importance and significance far beyond the Netherlands borders.

The pharmaceutical industry, at one time based mainly on the supply of products from the tropics, has expanded enormously in both scope and output. Some of its special products, such as hormones, for example, have won a world name. Again and again new specialized manufactures appear, such as thixotropic gels for drilling mud or the penicillin drugs made by the yeast and alcohol factory at Delft.

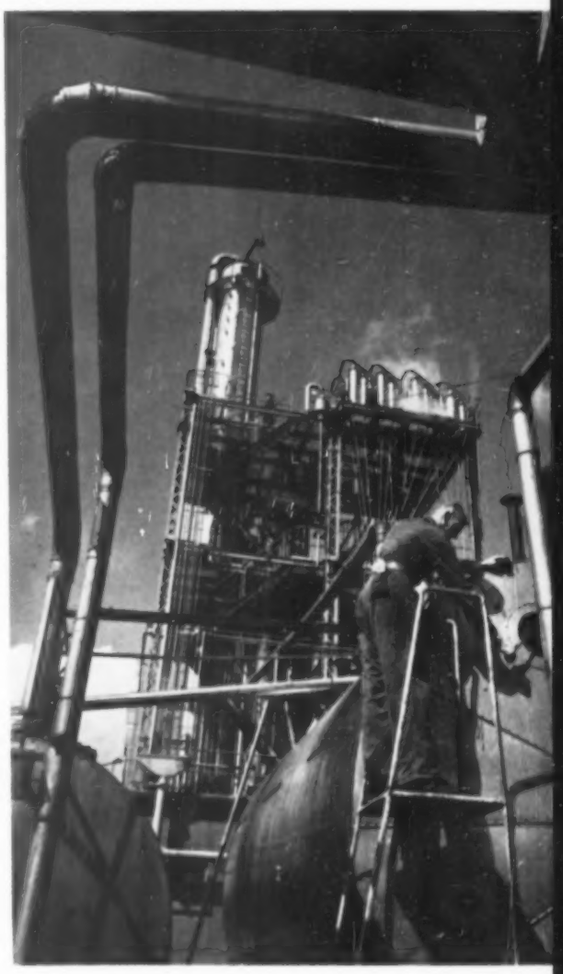
Holland also has an important chemical industry based on agricultural products, such as the large potato flour factory which provides the raw materials for dextrine, glucose, glue, etc.

The list of chemical products of Netherlands origin now exported to world markets has grown in recent years to an almost incredible length, so that it is possible to mention only a few.

First place in Dutch chemical exports is taken by artificial fertilizers, nitrogenous materials and phosphates. The State Mines Holland is supplying overseas plants with polyethylene caprolactum, a raw material for the making of nylon, and many coal tar chemicals. On the long list, too, are such products as acetic acid for the carbide industry, potassium permanganate, saccharine, liquid sulfur dioxide, diphenylol propane prepared by a Dutch-invented process, and various catalysts for the oil industry, products of the sulfuric acid factories and many plastics, synthetic resins and lacquer resins.

The Dutch paint and pigment industries find sales for their products all over the world. Other exports include perfume and flavorings; soap, wax and cleaning materials; pharmaceutical products among which vitamins and hormones should be specially mentioned; carbide with its many derivatives; insecticides and weed killers in great variety and the raw materials for their manufacture; monochloride acetic acid; activated carbon; and glycerine, the latter manufactured synthetically in the largest factory of its kind in Europe—these are just a few of the many products with which the Netherlands chemical industry takes an honored place in the world market.

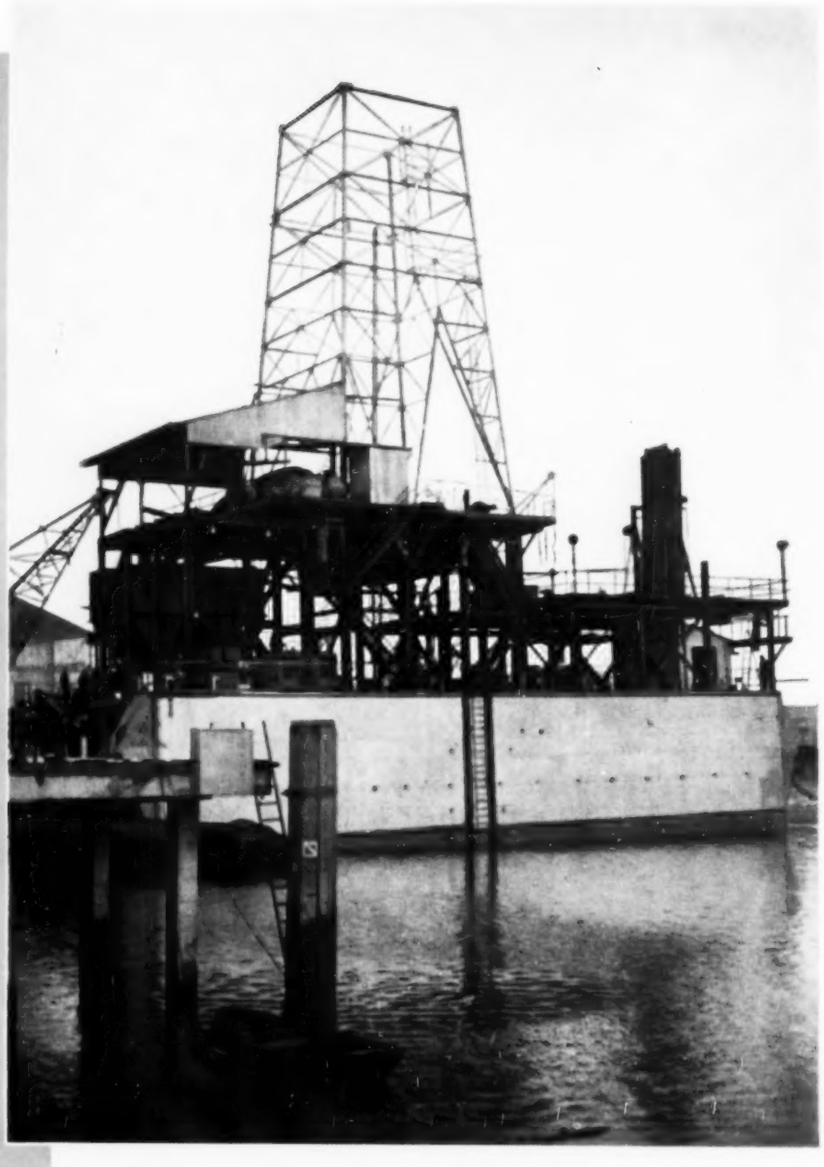
A Cyclohexanol-Cyclohexanon plant.



Submersible derrick barge - to be used in conjunction with a floating drilling tender - constructed in the Netherlands.

Swarttouw manufactured and erected the steel structures and platforms on the «sit-on-bottom» unit.

This derrick barge has been specially designed for drilling operations in the inland waters of Nigeria.



SWARTTOUW

MANUFACTURER OF TANKS - PIPELINES - EQUIPMENT

Part of the tankfarm at „Nieuwe Matex N.V." at Rotterdam's (Holland) Third Oil Harbor.

In just over one year Swarttouw did build for the „Nieuwe Matex N.V." of the Phs. van Ommeren concern 103 oil storage tanks of different sizes with a total capacity of approximately 8.500.000 c.ft.

Storage tanks for chemicals at »Pakhuismeesteren N.V.« at Rotterdam (Holland) Third Oil Harbor.

Co-operation of Swarttouw's designing, production and erection departments resulted in this tankfarm for storing approx. 700.000 c.ft. of various chemicals at Pakhuismeesteren's tank storage farm on the Third Oil Harbor, Rotterdam, Holland.
Special attention was given here to the movement of the products, for which purpose the pumping units were placed in the center of the tankpit.

SCHIEDAM HOLLAND

AND STEEL STRUCTURES FOR THE OIL INDUSTRY

KETJEN Koninklijke Zwavelzuurfabrieken v/h Ketjen N.V. Amsterdam

KETJENCAT M.s. Fluid Cracking Catalyst

Ketjen started production of micro-spheroidal fluid cracking catalyst in 1953 under a license from American Cyanamid Company, New York, and are selling this type of catalyst under the trade name KETJENCAT. This catalyst can be varied in accordance with special requirements of the various refineries.

KETJENFORM M.s. Fluid Hydroforming Catalyst

A plant for manufacturing fluid hydroforming catalyst has been in production since 1955. This type of catalyst can be used in fluid hydroformers operating under a license from Esso Research and Engineering Company. It is a microspheroidal catalyst containing molybdenum on an alumina base.

KETJENFINE Hydro-desulfurization Catalyst

For hydro-desulfurization purposes Ketjen manufacture cobalt/molybdenum catalysts in pellets of the usual sizes. Cobalt and molybdenum contents are chosen in accordance with the refiner's requirements. Chemical and physical properties of Ketjenfine are outstanding. Extensive tests by various oil companies have been carried out and have given full satisfaction.

CYANAMID KETJEN

CK Platinum Reforming Catalysts

In August 1958 Cyanamid Ketjen N.V. started the production of platinum reforming catalysts. These fully regenerative platinum catalysts give outstanding performance in upgrading low octane gasolines to high value motorgasoline components in catalytic reforming units.

„X" CATALYSTS

Improvements on the above mentioned catalysts are the objective of our research efforts and are carried out in our well-equipped laboratories and pilot plant facilities.

SULFURIC ACID

Ketjen have been makers of all grades of sulfuric acid since 1835. From the beginning of the oil industry, Ketjen have supplied sulfuric acid to refineries.

LIQUID SO_2

Ketjen have one of the biggest plants in Europe for making liquid SO_2 of a very high purity. This product is shipped to oil refineries all over the world both in drums and in tankcar lots.

Koninklijke Zwavelzuurfabrieken v/h Ketjen N.V. Amsterdam

KETJEN

are serving the Oil Industry

In packing and transportation problems the Ketjen Company not only acts as an advisory and consulting bureau, but also has developed special transportation and handling systems for overseas transport of m.s. catalysts: e.g. Ketjen has developed special king size containers, which have been of considerable advantage to the refineries.

Saving on packing and transportation costs can also be realized by bulk transport. For bulk transport to the European refineries Ketjen has developed a special KETJEN POLYSIUS system, which has been installed in roadcars, railroad tankcars and steel containers. With this system the tankcars can be discharged over a considerable distance, with minimum dust losses, at a rate of approx. 1 ton/min.

A more efficient use of fresh m.s. catalyst in fluid catalytic cracking operation is provided by the continuous addition and measuring system, developed and patented by Ketjen. The essential parts of this system, the KETJEN FEEDING and KETJEN WEIGHING DEVICE, can be made available to refineries.

At Ketjen's plants in Amsterdam a special laboratory is available to all refineries for testing fresh and used catalysts.

Ketjen subsidiaries

imacti

INDUSTRIEELE MAATSCHAPPIJ ACTIVIT N.V.

P.O. Box 240 - Amsterdam

IMACTI produces a complete range of ION EXCHANGE RESINS

IMACTI has also developed and patented the IMMEDIUM filtration method

Duper

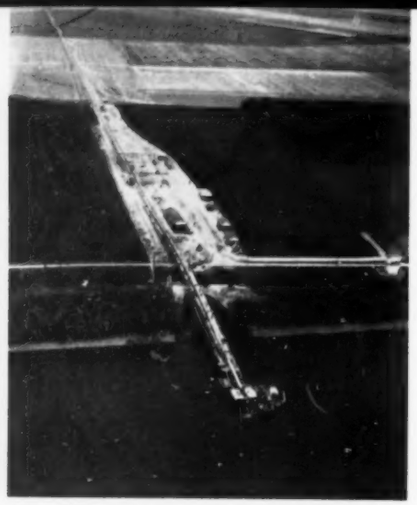
DUPER WATER CONDITIONING Co.

P.O. Box 196 - Amsterdam

Duper is designer of and contractor for all kinds of water conditioning equipment.

The sale of catalysts and other Ketjen products is handled by

Nederlandsch Verkoopkantoor voor Chemische Producten N.V. 63 Mauritskade, Amsterdam, Holland, P.O.B. 4038, Telephone 54322, Telex 12270, Telegrams: Chemicals



The laying of a 1.2-mile-long mattress to be sunk in the river Hollands Diep for the Rotterdam-Ruhr (Germany) pipeline.

van Hattum and Blankevoort

Hydraulic engineering.

Where in the world is a hydrologic laboratory covering 13,000 square miles? Where in the world are hydraulic engineers and technical experts, dredging firms and dikemakers and harbor constructors in whom the experience of over 2,000 years of battle against water is concentrated?

In the Netherlands, only in the Netherlands? For the whole of that country has been for twenty centuries the training ground and experimental station for hydraulic engineering.

In the 15th century the Bishop of Bremen asked for the help of the Dutch to reclaim marshes in his territory; in the 17th century Dutch experts went to England to build dikes and drain land there; in the 19th century the Dutch hydraulic engineer Conrad was the right hand man of Suez Canal builder De Lesseps; and since then Dutchmen have been imparting their knowledge and experience in this field all over the world, rendering service in a thousand ways with methods derived from both theory and practice. It was, however, in their own country that the Dutch first gained their experience in building dikes, making quay walls and harbors, and digging canals.

Messrs. van Hattum and Blankevoort N.V. of Beverwijk, Holland, are worthy representatives of Dutch hydraulic engineering. Back in the 19th century, a Dutch engineer engaged in the construction of a harbor in the Argentine asked for the assistance of his compatriot J. C. van Hattum, head of a family firm which had specialized in Holland in combatting the onslaught of the sea. At about the same time another Dutch firm, Blankevoorts, was working in the same field. In 1905 they decided to cooperate in their activities, first as two family concerns; later they merged into a single concern. For over half a century they have carried out a great part of the important works which Dutch engineers have undertaken not only in the Netherlands but also in other countries.

Among these varied activities have been docks in the Suez Canal, in Spain, Brazil and France, the world-famed Zuyder Zee works with its enormous dam, the tunnel under the River Meuse in Rotterdam, and such engineering projects as the building of factory installations for blast furnaces, steelworks, and mines.

Each new work presents new problems which in turn have produced new technical solutions. The concentrated skill of many centuries is combined with the methods of today. In the three-quarters of a century during which the van Hattums and the Blankevoorts have been carrying out their excavations and constructional works they have accumulated so much experience and knowledge that today no project is too large or too specialized for them to tackle, no country too remote and no soil or water too difficult for them to operate in.

For this reason the most tricky part of the new Rotterdam-Ruhr oil pipeline, the first of the three large pipelines to link up the center of Europe with the distant coasts of the Mediterranean and the North Sea, was entrusted to an engineering group under the management of van Hattum and Blankevoort.

During the second world war, the construction of the pipeline Pluto under the English Channel was an outstanding project. Since then no underwater pipeline has attracted greater attention than the oil pipeline just laid through the Hollands Diep waterway over a length of about $1\frac{1}{2}$ miles. It is the largest submarine pipeline in the whole of Europe. The work was carried on uninterruptedly day and night for 48 hours, during which the completely welded pipe exactly $1\frac{1}{2}$ miles long was laid on the bottom of the channel. The river itself is about 40 feet deep at the chosen spot, and at every change of tide there was a very strong ebb or flood current sweeping through the wide channel. To make it sink easily, the seemingly endless 24-inch pipe was given a thick concrete sheath. Two 15-ton winches were erected on the south bank to provide the steady pull into and through the river, whilst a host of Dutch dredgers stood by to close up the 13-foot trench in the river bed as soon as the pipeline was in position.

As already mentioned, for most projects such as harbor construction, various dredging operations and other works, new technical solutions and methods have to be found which are often relevant only to those particular problems. Sometimes, however, there are instances in which a technical innovation arises which is applicable to a number of works and for a number of years.

In the Netherlands, for example, all buildings along the coast as well as those in the provinces of Western Holland—houses, factories, churches, palaces, lock towers or quay walls—must be built on piles. For centuries it had been the practice to drive moderately-sized wooden piles through the muddy soil on to the firm sandy layer at a depth of up to 60 feet. In recent years these wooden piles have made way for concrete piles, but it was found that the repeated falling of the pile-driver was liable to cause the concrete piles to crack, allowing both ground water and sea water to damage the foundations, just as the wooden piles often became split, threatening their firmness and security.

To overcome these difficulties van Hattum and Blankevoort, with their great experience in the construction of heavy quay walls to withstand heavy pressure and punishment, devised a new method of sinking foundations which has proved a complete solution to the problem. They used a much heavier pile with a diameter of no less than $6\frac{1}{2}$ feet, compared with the previous normal size of 15 sq in and a weight of 65 tons each instead of the normal eight tons. It was found that these mammoth piles, used as the foundations for heavy quay walls, could absorb the buffeting and stresses of even the largest and heaviest of ocean-going vessels without bending or breaking.

The task of driving these colossal piles into the ground presented another technical problem whose solution demanded the development of a new technique, taking into account economics as well as engineering factors.

The solution was found in the use of two pontoons and a pile-driving scaffolding carrying a drilling pipe of a diameter of about $7\frac{1}{2}$ feet. Inside this pipe is a cutter-suction machine which slowly drills into the bottom of the sea bed and sucks up the loose mud. By means of two winches erected on board the pontoons the latter are actually lifted partly out of the water and thus weigh down upon the upper rim of the drilling pipe. In effect, therefore, the great weight of the pontoons presses the drill into the hole. When the drilling pipe has reached the required depth, the huge concrete pipe, brought to the site by ship, is hoisted into the pipe and then sunk with a pressure of more than 400 tons. This ensures security, because in practice the ordinary Dutch pile need never carry more than 50 tons.

It was by this method that van Hattum and Blankevoort built the new Netherlands Naval Base at Den Helder, as well as the huge quay walls in Karachi Harbor, where these 56-ton piles were sunk within three or four hours.

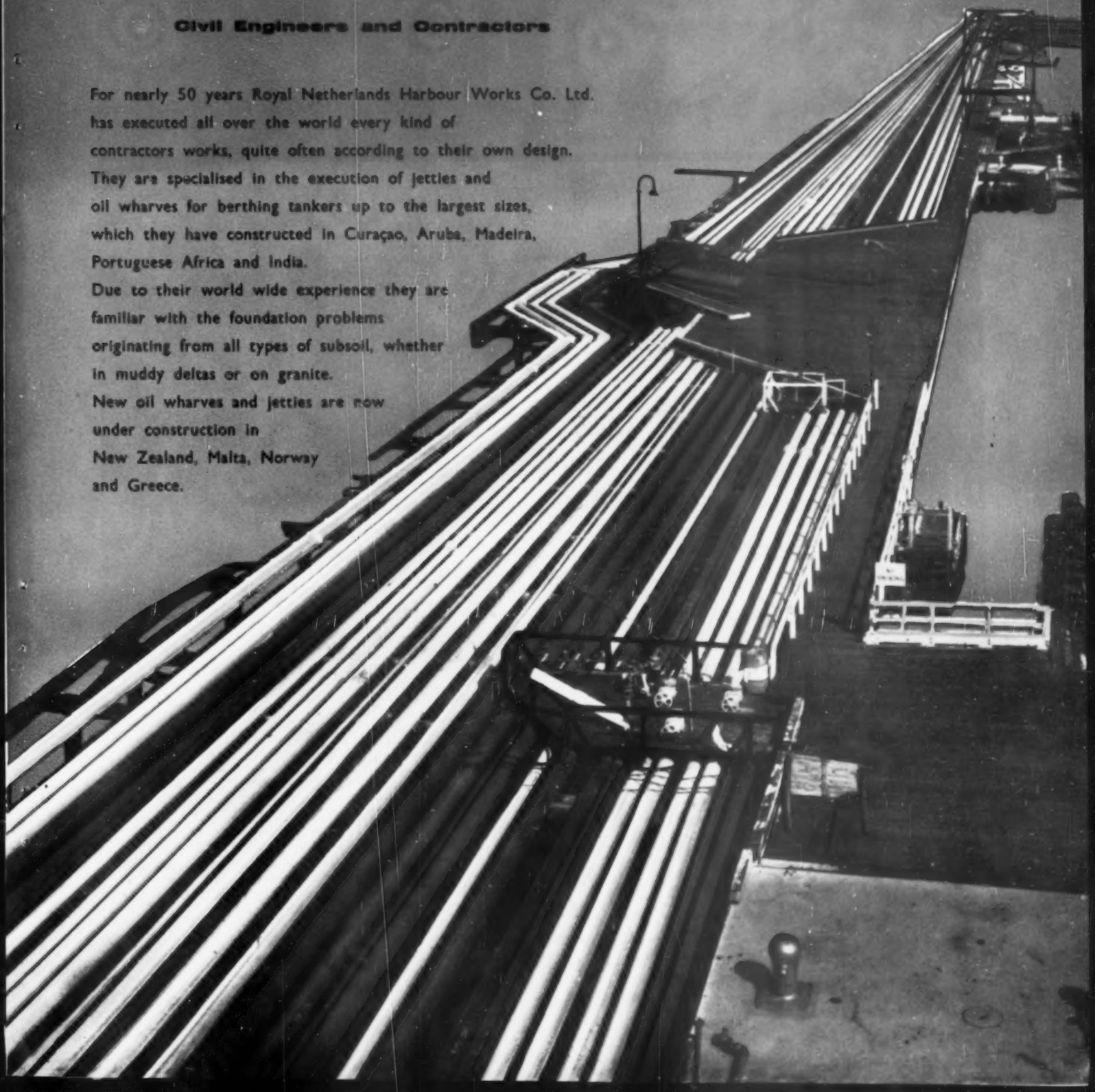
Such projects as these, the Rotterdam-Ruhr pipeline and the construction of harbor walls in and outside the Netherlands is only part of the work carried out by this firm in many countries. Sometimes alone, and sometimes with other firms, they build harbors in Britain, quay walls in Pakistan and bridges in Nigeria, as well as executing large dredging works in Australia or mammoth ground excavations in Spain. No matter what the size or how difficult the natural conditions, this Dutch firm with its wide experience of almost any conceivable engineering and hydrological project is at the world's disposal.

Royal Netherlands Harbour Works Co. Ltd.

AMSTEL 216 AMSTERDAM | TELEGRAMS: DREDGERS - AMSTERDAM | TELEPHONE 32412

Civil Engineers and Contractors

For nearly 50 years Royal Netherlands Harbour Works Co. Ltd. has executed all over the world every kind of contractors works, quite often according to their own design. They are specialised in the execution of jetties and oil wharves for berthing tankers up to the largest sizes, which they have constructed in Curaçao, Aruba, Madeira, Portuguese Africa and India.
Due to their world wide experience they are familiar with the foundation problems originating from all types of subsoil, whether in muddy deltas or on granite.
New oil wharves and jetties are now under construction in New Zealand, Malta, Norway and Greece.



COMPRIMO N.V.

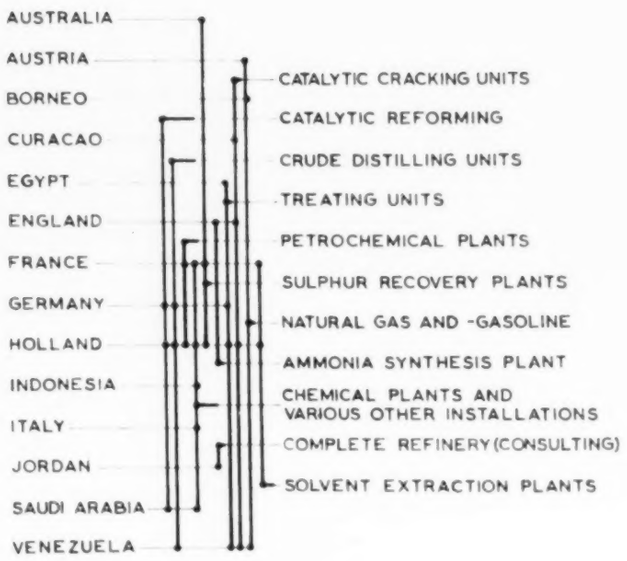
Amstel 21 AMSTERDAM-C.

Largest independent Engineering Organization in the Netherlands.

Thirty-five years experience as Petroleum and Chemical Engineers. Comprimo offers complete engineering and contracting services through a staff of 300 employes.

- Process Engineering
- Mechanical Engineering
- Civil Engineering
- Procurement
- Consulting
- Contracting

Since 1945 Comprimo has designed installations for the petroleum, natural gas and chemical industries in the following countries:



View of Crude Distilling Unit from Fluid Cat Cracker both engineered by . . .

COMPRIMO N.V.

The fight against soil corrosion

Key and Kramer Asphalt Ruberoid N.V.

For many centuries Netherlanders have been digging in the damp Dutch soil. Whereas in most other countries the farmers only went down into the earth one spade deep, in the Netherlands canals have been dug, dikes have been constructed and fields drained.

Indeed, long before Roman times, the inhabitants of the Low Countries along the coast, using the most primitive tools, moved more than 100,000,000 cubic yards of soil to make their artificial mounds, or terpen, on which they lived. These early earthworks alone represented a movement of as much soil as was dug out centuries later by 60 steam dredgers during the construction of the Suez Canal.

That was the background against which the Dutch later built their dikes, excavated their canals and reclaimed the land to form their famous "polders".

By the beginning of the present century the Dutch had moved 10,000 million cubic yards of earth for this purpose, a work equal to the digging of 100 Suez Canals.

All these works with the Dutch soil, extending over hundreds of years, brought with it an experience and a familiarity to be found nowhere else in the world. All the good and bad qualities of the soil became known and the many techniques of earth moving and soil mechanics were mastered—to be made good use of wherever soil problems had to be solved.

One of the most troublesome qualities of the Dutch soil is its chemical composition which even at the present time causes millions of guilders' worth of damage by corrosion to the pipes, cables, etc. buried in it.

In the battle against the water, Dutch engineers have found new methods and measures. Against corrosion many methods have been developed to protect pipes against the action of the soil. Among the best of these is asphalting. Key and Kramer have been traditional users of asphalts, for before the turn of the century they were using it for roof coverings. It has, in fact, played an important part in the whole Key and Kramer production program as well as in the Ruberoid activity of this firm.

As technical processes improved and the total length of pipe laid in the Netherlands continued to grow, the asphalting of this pipe became of more and more significance, and was carried out more and more on a scientific basis. These circumstances have made the asphalting of pipe, especially for the oil industry, the main activity of Key and Kramer. Their factory for this purpose at Maassluis near Rotterdam, is the largest asphalting plant in Europe.

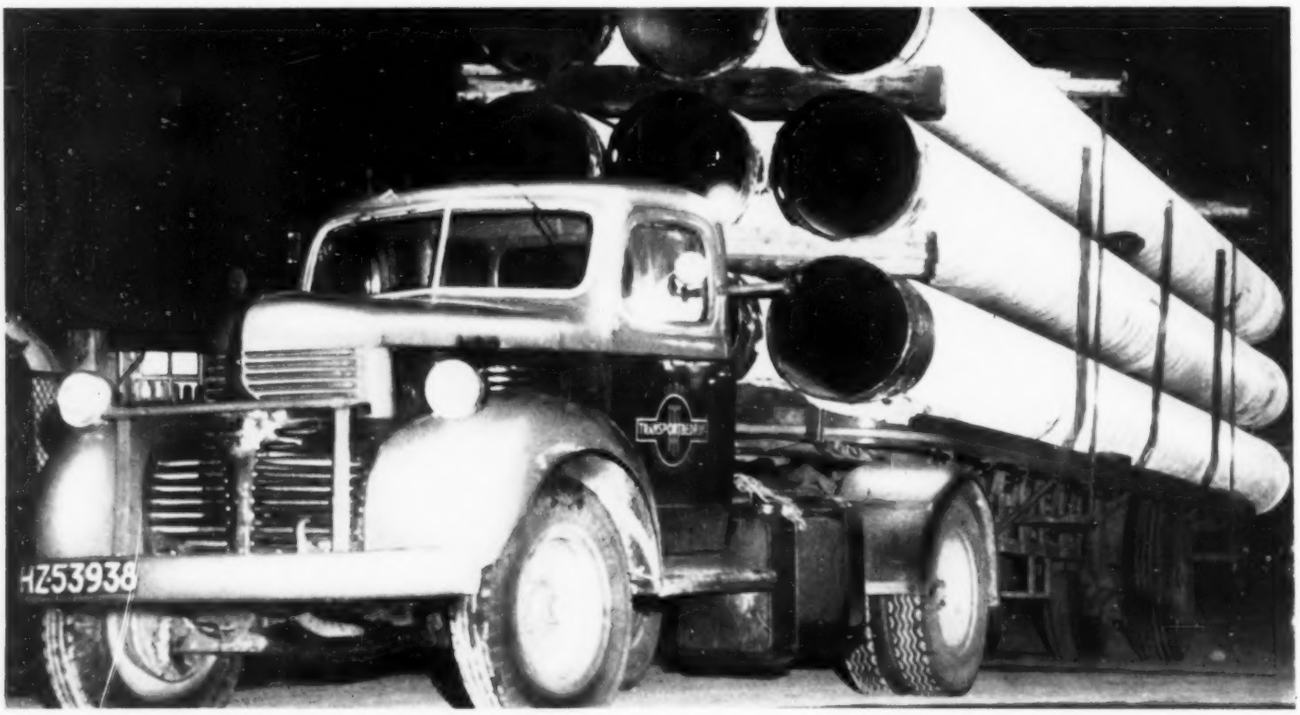
The Key and Kramer asphalting system has several special features. It begins with the de-rusting of the rough pipe, a process carried out by a chemical rather than a mechanical method. By the use of hydrochloric-phosphoric acid the pipe is stripped of rust both inside and outside, whilst the mill-scale is also removed. All traces of acid are then removed by immersion in an alkaline water bath of pH 8.

Inhibitors are added to prevent the actual iron being affected by the acids along with the rust. Finally the pipe is given a thin asphalt skin by first immersing it at a temperature of 80° C in a bath containing 2% of phosphoric acid. The phosphate skin thus produced results in the first layer of asphalt becoming better bonded to the pipe than if it were cleaned only mechanically.

Over the first priming layer, when dried, a seamless covering layer of bitumen 3.5 mm thick is applied, followed by one or more wrappings which are actually vulcanized onto the covering layer so that together with the wall of the pipe they form an unbreakable whole. Then comes the outer layer of lime which reflects the sun's rays, prevents the asphalt from becoming sticky and enables any mechanical damage to be easily detected.

This process is carried out on a conveyor line by means of machines designed and developed by Key and Kramer. About 20 miles of pipe is handled weekly in thicknesses varying from one inch to 50 inches. Before the asphalt pipe leaves this production line it undergoes a sparking test at a voltage of 80,000 V: this ensures that no pipe leaves the factory with the covering layer showing even one small pinhole. Any such hole discovered by the sparking test automatically brings the production line to a standstill. Only when the small hole has been repaired can the production proceed.

Truck load of corrosion protected line pipe.



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31 Electrotechnische Industrie v h Willem Smit & Co. N.V., Ringdijk 402, Slikkerveer
33 Willem Smit & Co's Transformatorenfabriek N.V., Groenestraat 336, Nijmegen
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33 N.V. Fabriek van Electrische Apparaten v h F. Hazemeyer & Co., Tuindorpstraat 61, Hengelo
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34 N.V. "Coq," Kanaalweg 72, Utrecht
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35 N.V. Nederlandsche Kakelfabrieken, Schieweg 9, Delft
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38 N.V. Werf Gusto v h Fa A.F. Smulders, Maasdijk 5, Schiedam
42 N.V. Kon. Maatschappij "De Schelde," Glacisstraat 165, Vlissingen
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45 Nieuwe Rotterdamsche Instrumentenfabriek "OBSERVATOR" N.V., Westzeedijk 52, Rotterdam
45 N.V. Staaldraadkabel- en Herculestouwfabriek v h J.C den Haan, Verlengde Torenstraat 5-9, Gorkum
49 De Vries Robbe & Co. N.V., Arkelsedijk 13, Gorkum
50 Werkspoor N.V., Oosterburgermiddenstraat 62, Amsterdam
51 N.V. Machinefabriek Stork-Jaffa, Groeneweg 2, Utrecht
51 Werf Conrad en Stork-Hijsch N.V., Waarderweg 80, Haarlem

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52 Röntgen Technische Dienst N.V., Delftweg 144, Rotterdam W 2
53 J. Duiker & Co's Fabriek van Apparaten en Werktuigen N.V., Rijnstraat 30-32, Den Haag
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67 Nederlandsche Dok en Scheepsbouw Maatschappij (v.o.f.), Klaprozenweg 75, Amsterdam
72 Koninklijke Zwavelzuurfabrieken v.h. Ketjen N.V., Nieuwendammerkade 1-3, Amsterdam

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38 Industriele Handelscombinatie "Holland," Postbus 6058, Den Haag
40 Havenbedrijf der Gemeente Rotterdam, Poortgebouw Stieltjesstraat 27, Rotterdam
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66 Reed Roller Bit Company Nederland N.V., Postbus 161, Leiden

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67 D. Drukker & Zn. N.V., Sarphatikade 12, Amsterdam
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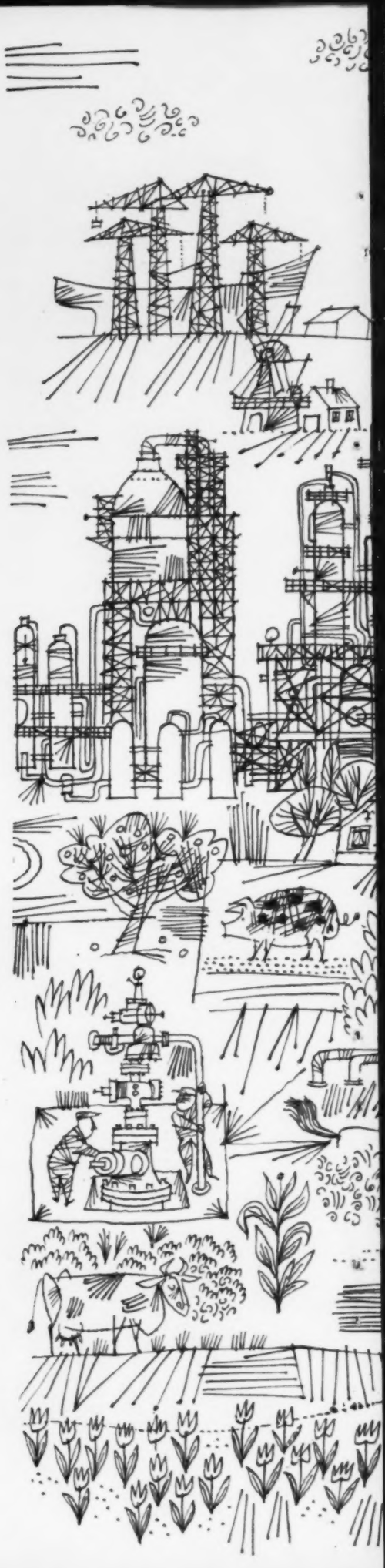


This section of the 1959
Fifth World Petroleum Congress
Issue of

World Petroleum

was commissioned by Ir. C. J. Adriessen, chairman of the Netherlands Oil Equipment Manufacturers c/o Nassaulaan 13—The Hague.

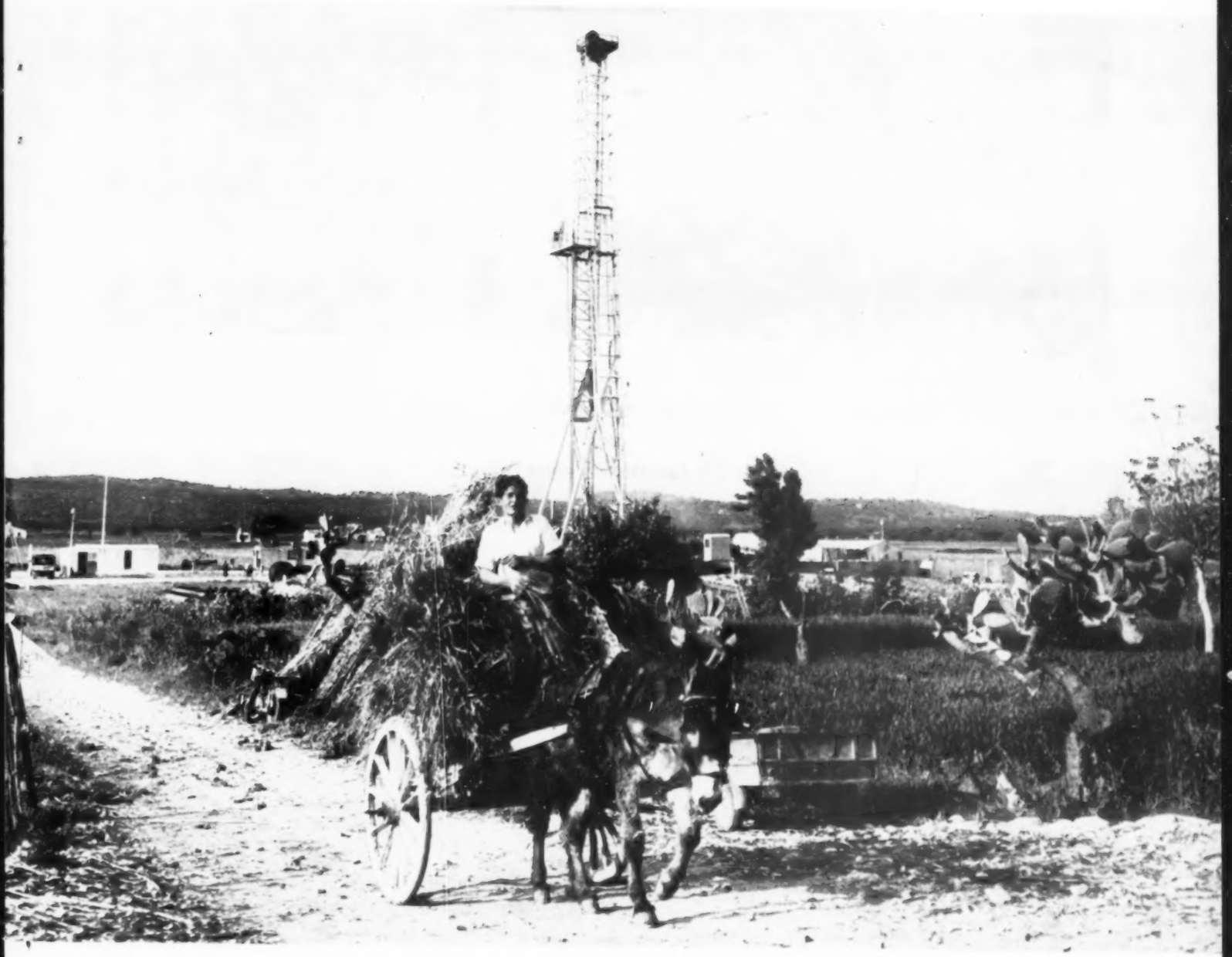
The scientific contributions in Part One were compiled under the editorial supervision of Dr. Ir. H. A. Stheeman, Managing Director of the N.V. Nederlandse Aardolie Maatschappij.

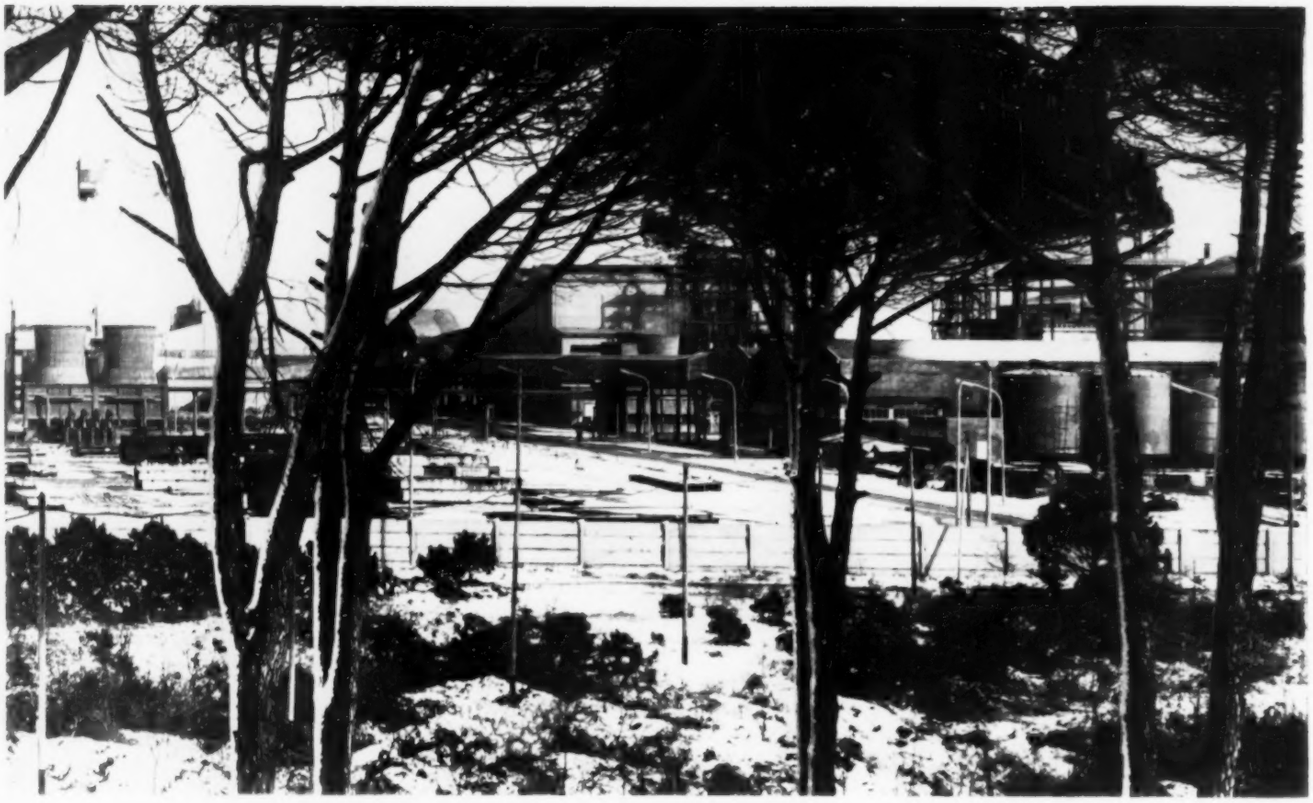
Contributing Editor for several advertisers was: G. H. Knap—Prinsengracht 134, Amsterdam.

Lay-out: R. Maters—v. Raephorststraat 10, Overveen (Haarlem).

Publishers: Palmer Publications
604 Fifth Ave., New York 20, N.Y.
Printed in the U.S.A.

ITALY





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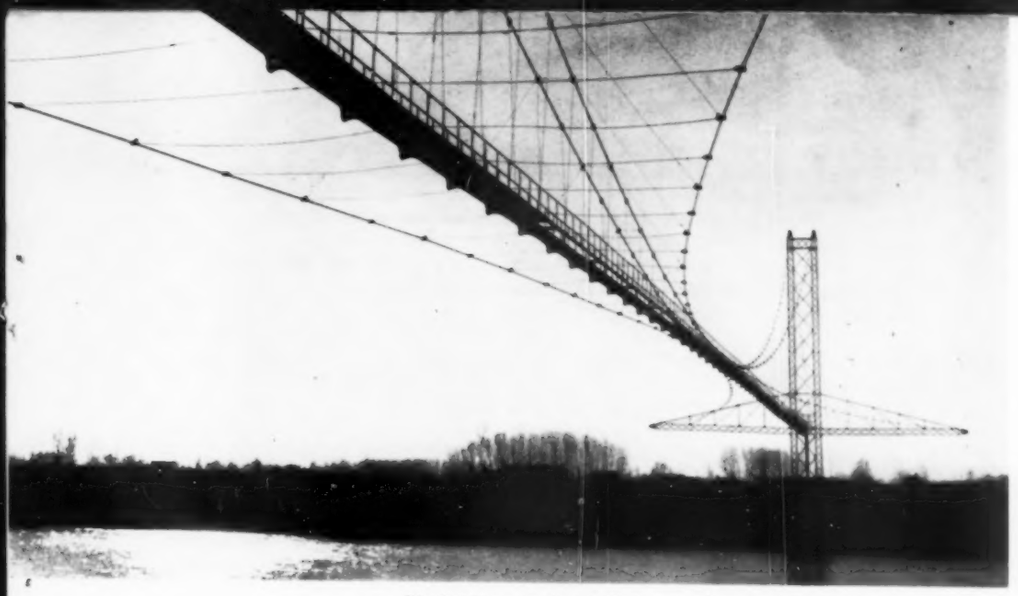


The 16" Cortemaggiore to Turin natural gas pipeline spanning the River Ticino

Development of the Italian Petroleum Industry

by **Enrico Mattei**
President, Ente Nazionale Idrocarburi

General view of AMIC's petrochemical plant at Ravenna

It is now generally accepted that in the coming few years the petroleum industry will be called upon to provide the bulk of new energy requirements.

This basic tendency, which may be slow to show itself to the full in countries endowed with plentiful supplies of solid fuel and water, has already been very clearly defined for some years past in countries lacking any substantial amount of coal production where the hydroelectric industry has been forced to exploit water supplies almost to the limit of economic advantage. In Italy, for example, a country particularly poor in solid fuels, this is clearly shown by comparing the relative contributions of each primary source of energy to whole energy supplies in 1938 and 1957:

Year	Solid fuels	Water & natural Steam produced electricity	Liquid fuels	Natural gas	Total
1938	59.43%	32.15%	8.36%	0.06%	100%
1957	17.60%	24.70%	46.60%	11.10%	100%

Since overall energy consumption more than doubled in Italy in the period under review, rising from 31,575,000 tons of coal equivalent to 67,575,000 tons, the increase was almost entirely covered by oil and natural gas. There were smaller increases in the field of water and steam produced electric power whilst solid fuel consumption hardly changed.

The need for ever greater supplies of oil and natural gas in order to maintain and give impetus to the present policy of economic development which aims at putting Italy among the most highly industrialized countries, sets a wide range of problems in exploration at home and abroad, crude oil refining, marketing of products and petrochemicals.

I shall deal with each of these subjects separately, bearing in mind, however, that they are all in one and the same context.

Exploration and production

Italy is made up of many kinds of geological formations which are not easy to interpret from the point of view of exploring for hydrocarbons. So much so that, for a long time, in spite of numerous surface showings, the general opinion was that Italy did not offer promising prospects of finds of any industrial significance.

Although during the last century a modest output of oil was obtained and used among other things for street lighting in some north Italian towns, exploration and production activities remained at a very low ebb.

In the early years of this century the State tried to revive the interest of operators by means of incentives in the way of rewards for production and drilling subsidies and tax and duty exemptions on imported machinery. But private enterprise, daunted by all the risks and costs involved and the difficulties of exploration, never really took up the challenge of these operations.

The State then decided to change its policy and take a direct hand in petroleum affairs, and when Azienda Generale Italiana Petroli (AGIP) was formed in 1926, besides being entrusted with the task of carrying out processing and marketing operations, it also undertook exploration work on the State's behalf, complementary to that carried out by private enterprise. Between 1926 and the immediate post-war period, private enterprise continued to be represented in Italy chiefly by the following three companies: Società Petrolifera Italiana (S.P.I.), Società Petroli d'Italia and Società Idrocarburi Nazionali.

The platform and tender for offshore drilling—the first to be used in Europe—belonging to SAIPEM, operating off the southern coast of Sicily.

These companies were mainly interested in exploiting small petroleum fields but AGIP, calling in the help of some of the best Italian geologists, undertook systematic large-scale exploration with the purpose of obtaining an exact and thorough knowledge of Italy's geological formation.

The figures for drilling operations carried out in Italy between 1926 and 1944, published by the Mines Division of the Italian Ministry of Industry and Trade, confirm these divergent tendencies between private and public enterprise.

Drilling operations in Italy between 1926 and 1944

	Meters	Percent for Exploration
AGIP	200,341	53%
Società Petrolifera Italiana (S.P.I.)	147,462	12%
Società Petroli d'Italia	139,515	4%
Others	75,649	38%

AGIP's exploration operations produced some positive results during this period although none of any great significance. (The very limited size of the fields discovered at this time both by AGIP and by private undertakings is shown by the figures for Italy's annual hydrocarbon output which reached a maximum of 27,000 tons of crude oil in 1932 and 55,000,000 cubic meters of natural gas in 1943).

But in the immediate post-war period there arose a new factor which was suddenly to make a radical alteration to the indifference and lack of faith which had previously affected petroleum exploration in Italy. In 1946 AGIP succeeded in proving, by using reflection seismic surveying, for the first time in Europe, that the natural gas field discovered in 1944 at Caviaga, 40 kilometers from Milan, was of substantial importance.

As soon as the proof of the size of the Caviaga field made it plain that this was the prelude to other discoveries in similar structures already defined geophysically, requests for exploration permits in the Po Valley by Italian and foreign ope ators began to come in thick and fast.

As there was no special petroleum legislation in Italy at this time, hydrocarbon exploration was governed by the 1927 Mining Act which was of too general a nature and not adapted to the specific needs of the petroleum branch. It did not, in fact, guarantee the explorers the right to a concession for any fields they might discover and exploration and exploitation of the fields were not governed by precise legislation adequate to give complete protection to the nation's interests in underground resources, everything underground being in Italy the State's inalienable property.

Two kinds of problems arose therefore and caused wide discussion in the press and political circles. The immediate one concerned the system for regulating exploration and exploitation in the Po Valley areas (where, as we shall see later, the major petroleum discoveries had taken place). There was also the more general problem of the nature of petroleum legislation, the need for which was obvious.

The solution to the first problem was found in the State keeping in its hands the underground resources in the Po Valley which AGIP, by using public money, had revealed after twenty years' activity. For this purpose the Ente Nazionale Idrocarburi (E.N.I.) was set up by Act of Parliament No. 136 dated February 10, 1953, and to it were granted exclusive rights to explore and develop the petroleum fields in the Po plain, and, also in this area, exclusive rights to build and operate a pipeline system. This Act entrusted E.N.I. with the task of promoting activities in the national interest in the hydrocarbon field and enabled it to carry out operations of processing and transforming, utilizing and marketing. For these ends the State transferred to E.N.I. its controlling interest in certain oil companies, that is to say in AGIP, in the Società Nazionale Metanodotti—SNAM (which deals with the transport of oil and natural gas), in ANIC, which carries out refining and petrochemical operations), and in other smaller concerns.

If the Act under which E.N.I. was set up was only approved by Parliament after lengthy, and at times particularly lively debate, the petroleum mining act suffered still harder birth pangs. Various bills were prepared from time to time based on different points of view.

The first drafts did not go further than laying down general principles, leaving wide discretionary powers in the hands of the public authority as to the Act's application, but later drafts and hence also the final regulations, veered towards much fuller and more rigid legislation covering in detail the conditions governing the operators' activities and giving adequate guarantees of their rights when proceeding from exploration to exploitation operations.

When drawing up the new Act—approved on January 11, 1957—the Government profited by other countries' experiences in petroleum production. Care was taken to set up legislation which would be an adequate safeguard against the rise of what would, in fact, be monopolies, by placing limits both on the area of each exploration and exploitation permit and on the number of permits to be allotted to each explorer. Minimum working obligations were fixed on penalty of the operator losing his rights and also the reductions which the area of the permits granted must undergo in the course of time, etc. As to the splitting of profits between State and holder of the concession, the latter is bound to pay the State, besides the usual taxes affecting industrial operations, a part of the product based on a sliding scale increasing with the amount of production per well, with a minimum of 2.50% and a maximum of 22%.

The legislation applying to the mainland of Italy was preceded by an Act of 1950 passed by the Sicilian Legislative Assembly

by virtue of the powers conferred on this autonomous region by the Italian Constitution to make its own mining regulations.

Operations started by some Italian and foreign companies after the passing of the Act produced their first results in 1953 with the discovery by Gulf Italia Company of an oil field at Ragusa which now has a productive capacity of about 2,000,000 tons per annum.

As soon as Sicily granted exploration permits the E.N.I. Group companies resumed the exploration activities which AGIP had already carried out in Sicily up to and during the war. Their efforts were crowned with success in October 1956 with the discovery at Gela of an oilfield which, although still under development with undefined limits, already looks more important than the Ragusa field. At the end of March 1959, twenty-five wells had already been, or were being drilled at Gela; some oil gathering centers, a coastal terminal and a plant for bitumen production had already been built.

The overall operations of the various companies in Sicily amounted at the end of 1958 to 171 exploration and production wells totalling 318,000 meters. They are going ahead well, especially those carried on by E.N.I. companies which own 13 of the 18 drilling rigs stationed in the island, and which also possess equipment for underwater drilling.

Outside the island's southeastern area, where the Gela and Ragusa fields are located, exploration has thus far been very hazardous both because of the unconformity between surface and deep structures and because of the thickness which makes physical prospecting difficult and necessitates deep drilling. In the rest of Sicily discoveries have been made, by companies belonging to the E.N.I. Group, of a quite large gas field on the western plain (Castelvetrano), where exploration is now going on, and of other smaller ones, also of natural gas, on the east coast near Catania.

In the Po Valley the state owned company had already carried out widespread intensive activities before the passing of the 1953 Act which granted it exculsive exploration rights in this area. By means of the systematic use of reflection seismic exploration it completed a general survey of the whole Po Valley and a detailed analysis of the many structural conditions which were gradually showing up. Thus the Caviaga field discovery was followed by those at Ripalta in 1948, Cortemaggiore in 1949, Cornegliano and Bordolano in 1950-51 and Correggio, Ravenna, Imola, Cotignola, Selva and Alfonsine in 1952 and 1953.

Natural gas production which barely reached 13,000,000 cubic meters in 1946 and represented about a fifth of the country's output, grew rapidly and in 1953 reached two billion cubic meters (88% of the nation's output).

This increase in natural gas production was made possible by the solution of difficult problems in the transport sector. It was necessary to meet the rapidly growing industrial demand for industrial gas by gearing, in the shortest time possible, the means and the specialized personnel required for putting a complex transport system into operation, consisting of main natural gas pipelines with regional and provincial branch lines, urban distribution networks and connections to individual users. At the end of 1953 the natural gas pipeline system belonging to the E.N.I. Group was already 3,110 kilometers long.

In 1958 production had risen to 4,790,000,000 cubic meters out of a total national figure of 5,176,000,000 cubic meters. The overall extent of the transport and distribution network of the E.N.I. Group companies was 5,000 kilometers at the end of that year.

As far as the Italian mainland was concerned, apart from the areas granted exclusively to E.N.I., the uncertainties over legislation and, still more, the unwillingness on the part of private Italian groups to place large amounts of investment in risky undertakings, kept the exploration operations of these groups down to a very low level, although, following the proclamation of the Petroleum Act, they were granted a number of exploration permits.

The 1954 55 discoveries at Alanno and Vallecupa in the Abruzzi had raised the hopes about that region's possibilities, but later drilling showed up a very faulty geological formation with small chance of finding large quantities of petroleum.

Gulf Italia, which had co-operated with Montecatini in a company called Petrosud to carry out exploration at Alanno and in other places on the Adriatic side of the peninsula, later gave up its operations and transferred its shareholding to Montecatini. On the other hand Cities Service, through an Italian associated company, took an interest in exploration in Italy and obtained exploration permits in the south.

If a look is taken at the amount of drilling performed in Italy in 1957 and 1958 the way in which operations, though showing a great increase over the pre-war period, are still mainly concentrated in the Po Valley, and to a lesser extent in Sicily, can clearly be seen. No definite figures are at present available for 1958 but in 1957, out of the 440,368 meters drilled for exploration, 64% are in the Po Valley and 22% in Sicily.

The Po Valley and Sicily are the areas which count the most for production, too. In 1957 1,261,540 tons of crude oil were produced in Italy mainly drawn from Sicily, 65,934 tons of gas condensate from the Po plain and 4,987,075,000 cubic meters of gas drawn almost completely from there also. In 1958 the respective figures had altered to 1,534,358 tons of crude oil, 64,927 tons of gas condensate and 5,176,000,000 cubic meters of gas.

As far as future prospects are concerned, in a few years' time about 5,000,000 tons of crude oil could be produced from the present oil fields whilst it is envisaged that natural gas output will reach about 5½ billion cubic meters in 1959 and may rise further in later years.

Operations Abroad

In spite of all efforts and the considerable output of natural gas and crude oil obtained, petroleum exploration by private companies and by E.N.I. in Italy has not yet succeeded in unburdening the country from its petroleum imports. On the contrary, they continue to increase as the years go on to meet the ever rising demand.

For this reason the problem has now become much more urgent of guaranteeing the country adequate sources of supply of its own abroad so as to reduce the costs and the unfavorable effect they have on the balance of payments.

Attempts in this direction had already been made in the inter-war period, then

Partial view of the San Donato Milanese industrial center. In the foreground and center: SNAM's warehouses and central workshops. In the background: E.N.I.'s office block and Research Center buildings.

ENTE NAZIONALE IDROCARBURI - E. N. I. - VIA TEVERE 50, ROME.

A public corporation, set up by Parliament in 1953, whose business is to promote and carry out activities in the national interest in the field of oil, natural gas and other sources of energy. To perform this task, E. N. I. operates through companies in which it has a controlling shareholding and through their associates: AGIP MINERARIA is responsible for the exploration for and production of oil and natural gas at home and abroad, and SNAM for the transport of oil and natural gas; the marketing company for petroleum products is AGIP, oil refining and petrochemicals are looked after by ANIC, and the utilization of nuclear energy is dealt with by AGIP NUCLEARE.

Oilfield exploration and production drilling operations on land and offshore.

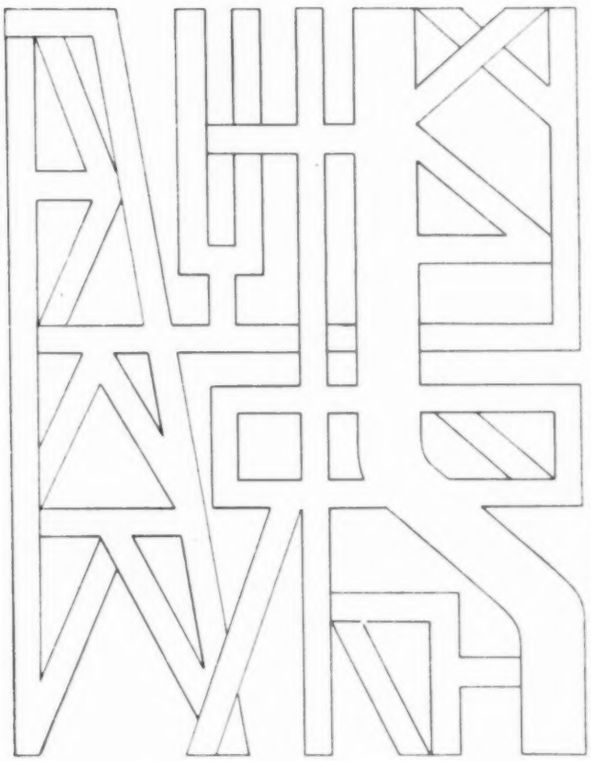
Water drilling operations.

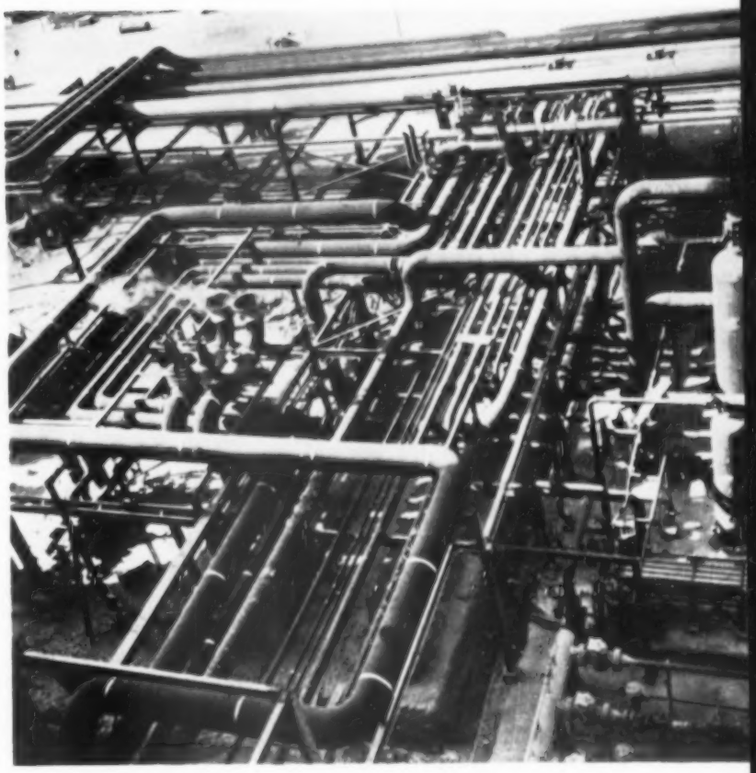
Construction of natural gas, oil and water pipelines, industrial and civil networks.

Installation of equipment for oil and petrochemical plants and nuclear power stations: reservoir tanks, refineries, gas bottling plants, natural gas purifying plants, chemical plants, cement mills, etc.

Metallographic inspections with X-ray, gamma-ray and ultrasonic equipment and by magnetic flux.

Cathodic protection for underground pipes, tanks, ships.





SAIPEM

drilling

construction work

Head office: San Donato Milanese, P.O.B. 4159, Milan
Telegraphic address: SAIPEM MILAN
Telephone: Milan 5353

One of the ENI Group of Companies

Jongmon

The office building of the E.N.I. Group at San Donato Milanese

as now almost entirely by the state owned company. Between 1927 and 1938 AGIP operated in Romania and obtained in all over three million tons of oil. In 1930 this same company acquired a participation in the exploitation of oil-bearing terrain in Iraq in the region of Mosul. But this participation had to be relinquished, by order of the Government, to Iraq Petroleum Company in 1936.

From 1925 on Albania was also the subject of exploration activities and later Eritrea, Ethiopia and Libya. They were mainly carried on by AGIP. The war prevented the follow-up of the initial results of activities abroad but these led to the formation of a group of oil experts on whom Italy could rely at the resumption of more active operations after the war.

At the present time AGIP MINERARIA has interests in Egypt, by virtue of its participation in International Egyptian Oil Company—I.E.O.C.—connected with the exploitation of three important petroleum fields at Belayim, Abu Rudeis and Feiran, on the western coast of the Sinai peninsula. This exploitation work is in the hands of Compagnie Orientale des Pétroles d'Egypte (COPE), under the guidance of E.N.I. technical staff. The capital of COPE is divided between two Egyptian organizations, which own 49%, and I.E.O.C. which owns the remaining 51%. In this way Egypt received not only royalties and the usual taxes, but also just about half the profits from the undertaking.

Present production figures for COPE stand at about two million tons per annum. The most recent drilling operations have proved the existence of reserves of more than a hundred million tons of crude oil which enable output to be rapidly stepped up with consequent benefit both to Egypt and to Italy. The latter already imports two thirds of the crude oil produced in the Sinai but the future will see a substantial increase in supplies from this source.

The latest concession by the Egyptian Government to COPE of exploration and exploitation permits covering a total area of 1,200 square kilometers, makes the prospects which can already be envisaged on the basis of the results obtained still more promising.

The agreement reached in 1957 between AGIP MINERARIA and National Iranian Oil Company (NIOC), which brought about the formation of Società Irano-Italiana dei Petroli (SIRIP), is well known internationally because of the discussion and comment it raised in Italy and abroad. According to this agreement, which conforms to the dictates of the new Iranian petroleum legislation, SIRIP's net profits will be shared between Iran, which will receive 50% in the form of royalties and taxes, and the two partners AGIP MINERARIA and NIOC which divide the remaining 50% equally between them.

This same principle of associating the producer country with the operations concerning the exploitation of its own petroleum resources formed the basis of the agreement concluded in 1958 between the E.N.I. Group and the Government of Morocco, which provides for the grant of a concession covering about 30,000 square kilometers in the province of Tarfaya to a joint Italian and Moroccan company.

The form of these agreements, which, at the time when such form was adopted for the first time, was considered by many to upset the traditional profit sharing relationship between lessor nations and lessee companies, has since been adopted by one American and one Canadian company which have obtained concessions in Iran.

The fact is that the nature of participation agreements, which answer the desires of the producer countries to play an active part in the exploitation of their own petroleum resources, on an equal footing with the foreign partner, is much more likely to make the identification of interests which is thus created of firmer and more lasting value. For an essentially consumer country like Italy, which is much more concerned with the necessity of having direct sources of supply available than with making high profits, the present form offers the highest advantage.

Refining

In the years between the wars the Italian refining industry was very modest in size. In 1931 local petroleum imports amounted to about 1,600,000 tons, more than 1,200,000 tons of these being finished products, representing about 75% of home demand.

With the aim of encouraging development in the refining industry, the State took various legislative measures, amongst which those of 1933 and 1936 were particularly important and resulted in a number of full cycle refineries being built.

By 1939, on the eve of World War II, Italy's overall refining capacity stood at something like 2,200,000 tons. In the course of a few years the proportion of crude oil to finished product imports was reversed. Between 1931 and 1939, notwithstanding the general rise in consumption, imports of refined products had dropped by half and fallen from 76% to 29% of total petroleum imports.

The serious damage inflicted on Italian refineries again necessitated heavy imports of refined products just after the war; but the petroleum industry was very soon rehabilitated, so much so that by 1948 Italian refineries were capable of processing 3,200,000 tons, more than before the war. This meant that by the end of that year it was already possible to cover entire domestic requirements of petroleum products from crude oil processed in Italy.

Speedy progress in the production of Middle East crude made it possible and economic at this time for further developments to be carried out in the refining industry, not only in Italy but in the other countries of Western Europe as well.

The various refinery building and expansion programs drawn up by individual countries and coordinated by the O.E.E.C., aimed in 1913 at a processing capacity around 62 to 65 million tons; but refinery capacity had already far outstripped this target by the end of 1953, reaching 98 million tons. The already apparent inclination towards expanding refining capacity had, in fact, received fresh impetus from the Iranian crisis of 1951 which deprived world markets of the 25 million tons annual capacity of the Abadan refinery.

This added impetus had its fullest repercussions in Italy because it became advantageous for the big international companies to install new refineries in this country which not only itself offered a potential market outlet of considerable size, but also was in a good position, as far as transport economics were concerned, between the oil producing countries on the one hand and the Mediterranean and Central European consumption centers on the other.

Thus there was a steady rise in the amount of crude oil processed by Italian refineries for the home market and, above all, for export.

There was continued increase in the consumption and export of petroleum products, however, even after the reopening of the Abadan refinery, which was met by a parallel further increase in Italian refining capacity, mainly achieved through the expansion and improvement of existing plants. At the end of 1958 the theoretical maximum throughput capacity of Italian refineries reached about 30 million tons per annum. In the course of this same year the amount

actually processed was 24 million tons of crude oil.

Crude oil processed in Italian refineries
(thousand tons)

Year	For the home market	For export	Total
1950	3.965	1.387	5.352
1951	5.252	2.122	7.374
1952	6.019	3.712	9.731
1953	6.898	5.945	12.843
1954	7.944	8.226	16.170
1955	9.395	8.212	17.607
1956	10.972	8.278	19.250
1957	12.030	8.764	20.794

The situation that over the past years has made the rapid ascent of the Italian refining industry possible has recently been undergoing changes corresponding to the changes taking place in the international oil market.

The ever more marked tendency on the part of the consumer countries and oil companies to erect new refineries in the consumer areas reduces the export prospects of those countries where refining capacity outdistances internal demand. The crude oil processing figures shown in the table demonstrate how, from 1955 on, the amounts destined for export have slowly increased ranging between eight and nine million tons per annum. This throws emphasis on the growing importance of the domestic market where consumption is steadily rising but at a reduced rate for all products except fuel oil.

Estimates drawn up by an E.N.I. study group of the requirements from each individual source of energy in 1965, lead to the conclusion that in five years time about 33 million tons of crude oil will have to be processed in Italian refineries, $5\frac{1}{2}$ million home produced and $27\frac{1}{2}$ million imported. This would enable $15\frac{1}{2}$ million tons of fuel oil to be produced which, however, would still be insufficient to cover all domestic requirements for this product, put at 17,200-000 tons in 1965. So it would still be necessary to import about another two million tons.

This situation highlights the importance of the heavy crudes produced in Italy and Egypt which help to reduce the disparity between internal consumption of fuel and light products. But the Italian refining industry is certainly face to face with the problem of finding a correct balance. It will be unable to keep the yields of light products down to the level of domestic requirements and will be forced to seek market outlets abroad for the excess gasoline, gas oil and kerosine produced.

Italy's future refining prospects seem, therefore, to be governed by two factors. On the one hand there is the question of the place which should be given to processing of directly or indirectly Italian produced crude oil in relation to foreign produced crude, and on the other hand there is the need to maintain an adequate standard of exports. These two problems affect both nationally owned refinery undertakings and those belonging to international companies, to which is largely due the rise in refining capacity in Italy in market conditions other than those obtaining at the present day. However, it is clear that for Italian petroleum producers the main concern is to have refinery capacity capable of supplying independently their home distribution networks and their markets abroad.

Marketing

Parallel with the development in consumption which has occurred in Italy during the past seven years, great strides have taken place in roadside distribution networks for gasoline, gas oil and oil gasoline mixtures for scooters and other two-stroke engine vehicles, and great improvements in the quality of the products.

Oil products marketing network in Italy
Selling points for motor fuels, June 30, 1958

Single pumps	Kiosk filling points	Filling stations	Service stations	Total
11.900	8.000	2.100	3.000	25.000
(47.6%)	(32.0%)	(8.4%)	(12.0%)	(100%)

The table gives an overall picture of the position of the Italian marketing system at June 30, 1958. This system, although mainly in the hands of the large integrated companies (AGIP, Esso, Shell, Mobil) has hitherto offered opportunities of operation to quite a number of small independent distribution networks on a regional or local basis. Recently, however, the concentration of networks has become more accentuated following the entry on the Italian market of British Petroleum which has taken over more than a thousand retailing points of all types from two smaller companies.

Improvements in the quality of motor fuels were begun on the Italian market three years ago when AGIP introduced a premium grade gasoline of 98-100 O.N. R.M. onto the market, thus beating all the other marketing companies in the so-called "octane number race."

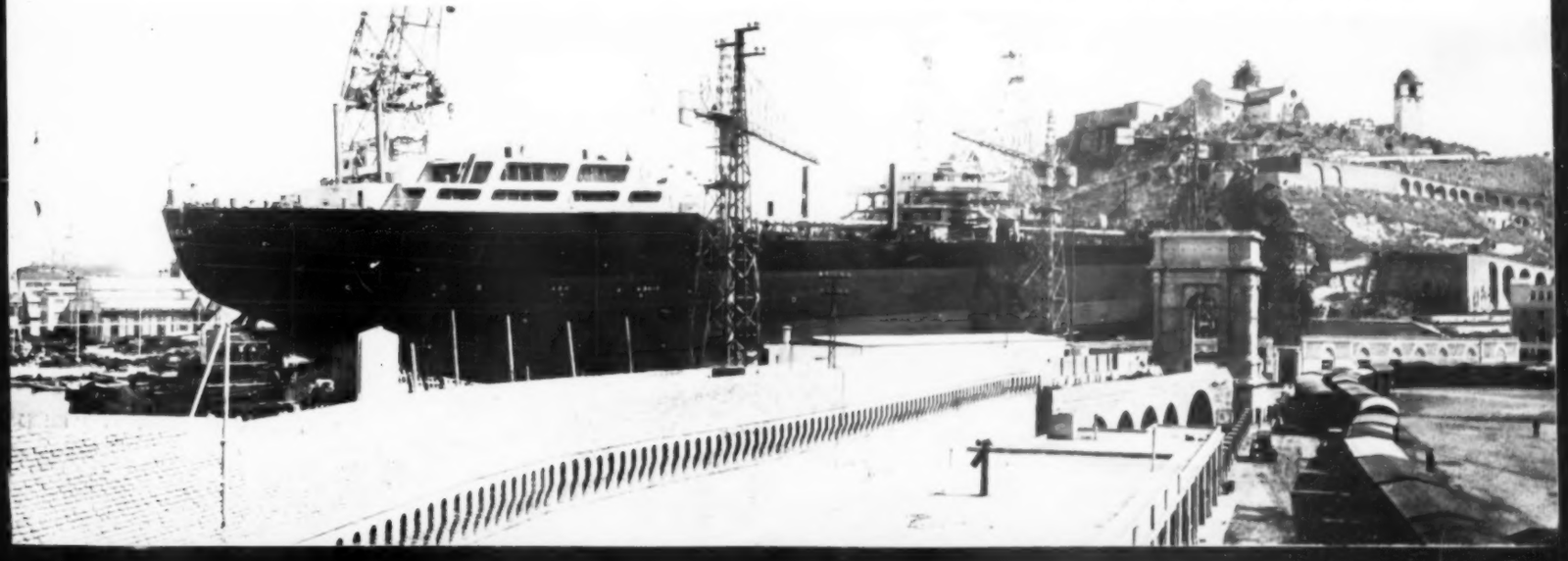
The stimulus for this improvement was provided by the special type of competition which prevails in the petroleum products market, that is to say the competition between differences in the quality of the product and not differences of price. The impetus behind the need to differentiate by quality was all the stronger in Italy because price competition was more or less impossible due to the very small refinery margin (given the yield structure which tends towards less valuable products) and to the small quantities of motor fuel sold by each retail station, which prevents a reduction of the marketing margin.

At the same time a second type of competition was taking place based on distributors offering better service to clients. This has had a very marked and speedy effect on the appearance of retail stations in our country too. The number of one or more pump selling points continues to diminish while on the increase is the number of kiosk filling points which include facilities for greasing, changing oil and pumping tires, and, most of all, the number of service stations with car washing and greasing facilities and often also repair shops, bar and restaurant. Recently motels have started to operate throughout Italy and these are becoming popular with motorists.

The structural features of Italian motor fuel consumption (majority of vehicles of low horsepower and low fuel consumption per unit due to the high gasoline tax, high gas oil consumption) are reflected in the structure of the marketing networks and their operation which are notably different from other countries.

In the United States, for example, a great number of retail points are not destined exclusively to selling gasoline but this activity is subordinate to others. In the United States there are no roadside gas oil filling stations because only less than 0.1% of all vehicles are run on diesel fuel. In Italy, on the other hand, gas oil pumps represent 16.2% of all the pumps in operation due to the wide use of diesel engines in heavy vehicles. This arises because gas oil is less heavily taxed than gasoline.

The turbine tanker AGIP GELA at 35,500 dwt in the Ancona shipyard.



Filling pumps for motor fuels at June 30, 1958

Premium gasoline	Gasoline	Gas oil	Mixture	Total
14,400	23,600	11,500	21,200	70,700
(20.4%)	(33.4%)	(16.2%)	(30.0%)	(100%)

Furthermore, the number of pumps supplying oil-gasoline mixture is very high in Italy because of the very many low horsepower motorcycles and scooters. This feature, which will probably remain constant for some time to come, is also met with in France and Germany and is rapidly gaining ground also in England.

In Italy the multiplicity of marketing companies and the lively competition between them have led to an abundance of selling points and the quantity of products sold by each is lower than the average for other countries. It is therefore likely that the rate of increase in the building of such stations attained in recent years will slacken in future with the exception of the less advanced areas in southern Italy and the islands, and that fresh capital investment in the marketing field will be mainly spent on improving existing facilities.

Petrochemicals

The Po Valley natural gas discoveries led after the war to the first achievements in the petrochemical industry, which was greatly influenced by the nature of this gas, in most cases composed of nearly pure methane (about 99%). In the beginning, therefore, most progress was made in petrochemicals based on methane.

The simplest form of application is to obtain synthesis gas for the production of ammonia and methyl alcohol.

Plants producing ammonia from methane are found at Novara and Ferrara (Montecatini), Marghera (Vetrocoke and Sicedison) and Ravenna (ANIC); at Novara methyl alcohol is also produced.

The second application is for acetylene; there are at present four plants producing acetylene from methane by a partial oxidation process, situated near Milan (SISAS), and at Marghera (Sicedison), Ravenna (ANIC) and Novara (Montecatini). In some of these plants ammonia production is partly based on the use of the synthesis gas obtained at the same time as the acetylene.

Acetylene is employed in the preparation of acetic derivatives (SISAS, Sicedison), vinyl derivatives (Sicedison) and butadiene (ANIC), the latter used for the synthesis of SBR rubber. At Ravenna a vinyl chloride plant is starting up (Società Chimica Ravenna, an associate of ANIC).

As a result of increased refinery output, petrochemicals were obtained from a feedstock of liquid hydrocarbons and refinery gases, for example in the plants at Ferrara and Rho (Montecatini) and Mantua (Sicedison).

Below are some OEEC statistics which show the rise in recent years of consumption of and production from natural gas, refinery gases, and liquid products.

This table does not include natural gas or petroleum used for ammonia synthesis.

The very marked expansion in this branch of industry will continue into the future as the present factories are enlarged and new projects are realized.

Productive capacity for polyethylene, for example, which at the end of 1957 stood at 10,000 tons, will have reached 50,000 tons by the end of 1960.

There are, in fact, at the moment factories in a more or less advanced state of construction, for marlex polythene at Rosignano Solvay (Solvay) and two for high pressure polythene in Sicily, one near Augusta (Celene) and one at Ragusa (ABCD). Celene will also produce ethylene oxide and its derivatives.

Polypropylene, the well known Italian discovery, is at the moment produced at Ferrara by Montecatini. This company has recently announced plans for a new plant at Brindisi for the production of ethylene and propylene derivatives.

After the completion of the new butadiene plant, based on the use of refinery butane, the ANIC factory at Ravenna will have an annual production capacity of sixty thousand tons of synthetic rubber.

Mention should also be made of the first plant (Sicedison) for the production of ammonia from oil-produced synthesis gas which will be situated near Augusta.

Year	Natural gas (thousand cu.m.)	Liquid hydrocarbons (tons)	Refinrey gases (tons)
1955	267,293	52,000	—
1956	328,992	63,000	—
1957	359,480	82,510	15,000
1958	586,945	235,000 (estimate)	21,500

Production, expressed in tons of carbon, for the last two years was:

		1957	1958 (estimated)	
		8,600	26,000	C_2 Polyethylene, dichloroethane, ethyl chloride, styrene, ethylene oxide, ethylene glycol
from liquid hydrocarbons		3,850	17,500	C_3 Isopropyl alcohol, acetone, polypropylene, propylene tetramer
		14,500	16,000	C_1 Methamol
		28,500	32,600	C_2 Acetaldehyde, acetylene
		14,991	20,840	C_4 Butyl alcohol, butyraldehyde, butadiene, butylene, sodium butyl acetate, acetic acid
from natural and refinery gases		2,306	16,700	C_4 Ethylacetate, synthetic rubber
				and higher aliphatics
	Total	72,747	129,640	

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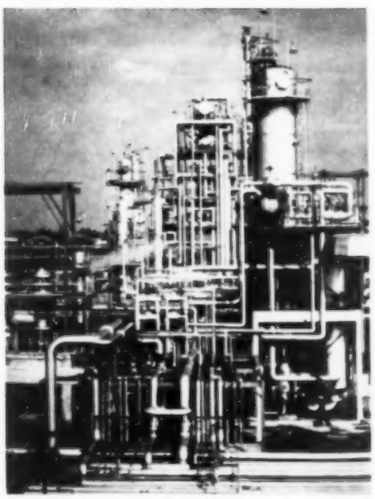

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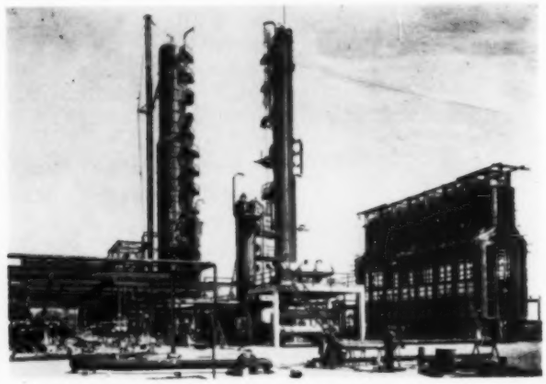
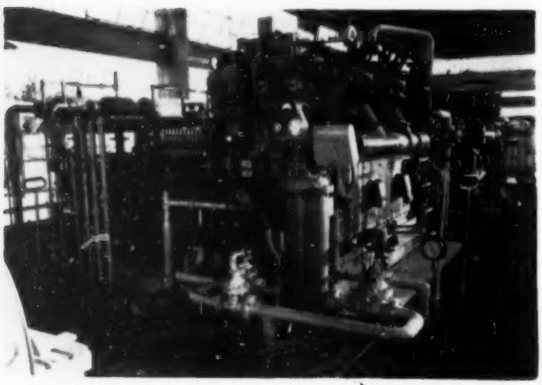


A view of the Rasom Refinery under construction by ANSALDO at Augusta, Sicily.



Type GMVD 6 motocompressors, with non lubricated cylinders, total 800 Hp., constructed by TERMOMECCANICA for the SAROM Refinery, Ravenna.

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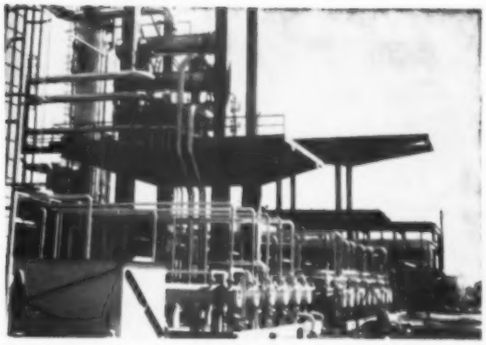

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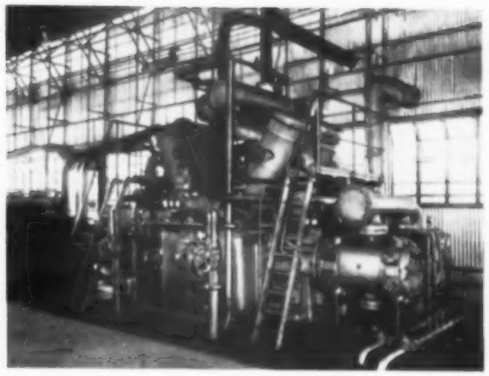

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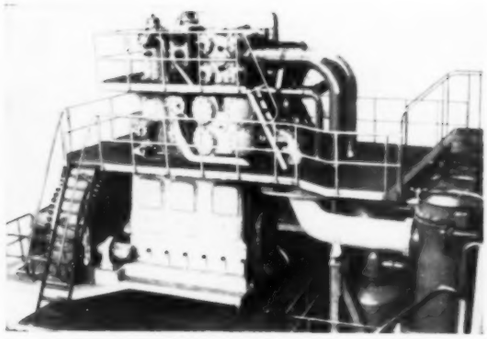
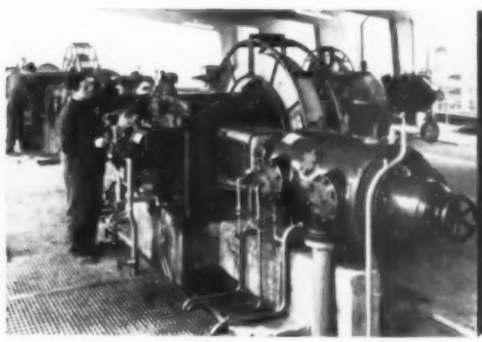




Refining and distribution of petroleum products in Italy

by Dr. Vincenzo Cazzaniga
Chairman, Unione Petrolifera

On the occasion of the Fourth World Petroleum Congress in Rome, June 1955, the Unione Petrolifera presented a review of activities in this branch of Italian industry, and illustrated the subject in a volume of statistics covering the five years 1950-54, during which a fundamental revolution had taken the Italian refineries out of the narrow field of supplying internal demand into a considerable export business.

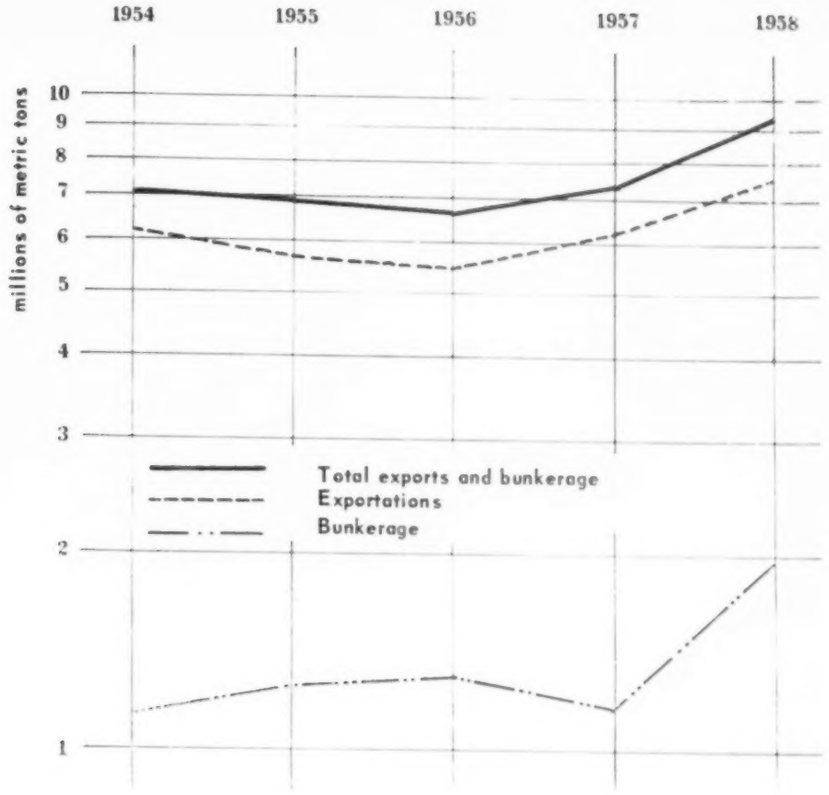
Today, on the eve of the fifth congress, a review of the five years 1954-58 shows not only an extensive and interesting development, but one which has consolidated the Italian petroleum industry to a position of first rank in western Europe and in the new European Economic Community formed by the six countries of "Little Europe."

Crude and Natural-Gas Production: Five years ago Italian methane production took first place in western Europe at three million cubic meters. This has been increased to five million—a production which can be maintained for another several years ahead of France, which probably will rank first because of the development of the Lacq field.

On the other hand, extraction of crude from the Italian subsoil had, up to 1954, made only a relatively insignificant contribution, scarcely more than 70,000 tons a year (about 1,400 b d). Discovery of the Ragusa field in Sicily by a private enterprise at the beginning of 1957 led to a production of more than a million tons (about 20,000 b d). Government enterprise also has discovered a Sicilian field, Gela, which has begun commercial production. Ragusa crude is heavy, and Gela still heavier; so the utilization of these two crudes presents some problems, especially Gela.

The crude obtained today in Italy represents about 13% of the production of the OECE countries, and about a fifth of the output disposable in the territory of the Common Market; it covers about 10% of the national requirement. However, because of the low quality of the products previously mentioned, part of the crude produced is exported, so that the amount supplied for interior consumption is less than this percentage.

While in Sicily the local mineral laws put private industry in a position of parity with government enterprise, in the territory of the peninsula there are two laws which are more restrictive. Recently, steps have been taken to modify these laws to encourage private enterprise to undertake



Italian exportation of finished products and international bunkerage

exploration for oil. Legislation in this direction was introduced two years ago, and perhaps the government will take the matter in hand.

Consumption: Fiscal pressure on petroleum products has a notable influence on consumption. Sales taxes on gasoline make up 71% of the price; 69% of the price of kerosine; 67% of gas oil, and 24% of the price of heavy fuel oil. Notwithstanding these burdens, consumption is increasing at a sustained rate which is forging ahead of the use of other sources of energy in Italy. This tendency is not uniform as regards all of the products—with considerable variation between them. Lamp oil has regressed; gasoline in five years has registered an increase of about 50%; gas oil has done as well; lubricants have been limited to an increase of 10%; fuel oil has touched 63%; and liquefied gas has exceeded 75%. The large increase of LPGas has occurred in part at the expense of gasoline consumption, because LP Gas, which at first was used only as a combustible, is now also being employed in automotive engines as a consequence of the very much lower tax.

Operations at refineries: Growth of consumption has been accompanied by a corresponding increase in activities at refineries. The raw material processed rose to 24 million tons in 1958 from 16 million in 1954; 63% of this has been used to supply the interior market and 37% for export.

The application of all possible resources of technology—in some cases to the raw materials previously mentioned—has permitted our industry to adjust refinery yields to the varying needs of the market which, as has been noted, indicate a notable equilibrium between white and black products. The result has been that the yield of gasoline, which in 1950 was 18.4%, had decreased to 13.7% in 1958; and the yield of combustible oil, which stood at 45% in 1950, had gradually risen to 49.2% in 1958.

Imports of Finished Products: The ability of Italian refineries to meet the needs of the national market was established during the preceding five-year period, and has further increased during 1954-58. For the most part, what remains to be done in meeting these needs applies to the following four products:

a. Aviation gasoline: Production of this product has not as yet begun in Italian refineries. Importation has been growing gradually in proportion to the development of air transport.

b. Lubricants are continuing to be developed by indigenous refineries, but importation of special types from foreign sources has not been eliminated.

c. Combustible oil is being imported in decreasing volume (except for temporary spurts during the Suez crisis) to supplement the domestic needs. To the end of last year, refineries were not able to cover demand completely, but they will succeed in doing so during the current year, and then importation of lubricants will cease.

d. LPGas importation has continued, although Italian refineries have been able in the past five years to increase rapidly the yield of this product, sufficiently to cover most of the demand for its use as a combustible. However, because of fiscal reasons, they have not been able to meet the demand for its use in automobiles; about half of this special demand must be covered by imports.

Exports: The year 1954 witnessed the high point in maximum development of one area of current Italian exportation of oil products. This was occasioned by a call to furnish supplies to fill the unexpected and temporary void which arose in the markets south of Suez following the unexpected closure of the Abadan refinery during the time when the program for new and enlarged refinery units in the Middle East had not as yet been completed. In 1955, with rapid clearing up of this situation, this outlet for exports became depressed; and in 1956 and 1957 there was another shrinkage due to the Suez crisis.

In 1958, the export situation virtually returned to that in 1954, but with two important changes: (a) distribution of products was directed almost exclusively toward the Mediterranean and other European markets; (b) exportation now absorbed the portion of heavy products and medium and light distillates which were sold at a discount.

In comparison with consumption in the

(Continued on page 18)

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Mobil Oil Italiana

More than half a century of activity in the oil business

Over half a century ago on May 14, 1901 the Vacuum Oil Company S.A.I. Genoa (now Mobil Oil Italiana S.p.A.) was formed. This company started to build up a market for high grade lubricants in Italy. The lubricants were imported from the United States. In 1935 it was decided that a modern refinery should be erected in Italy capable of producing the high grade lubricants heretofore imported. In 1935 the construction of a refinery was started in an area of 62 acres near Naples, about 2.5 miles from the bay of Naples and about 5 miles from the Volcano Vesuvius. Late 1937 the refinery went on stream. Its capacity was about 300,000 tons per year or about 6000 barrels per day. During the war the refinery was almost completely destroyed. After the war prompt steps were taken to rebuild the plant and in January 1947 it was again on stream, although only on topping operation.

Naples plant refining Middle East crude

Among the activities promoted by Mobil Oil Italiana after the end of the war for giving impact to the company's operations and to the industrial development of Southern Italy, the export of oil products should be particularly pointed out. Mobil Oil Italiana was the first oil company in Italy in submitting to the Ministries of Industry, Finance and Foreign Trade a project for processing crude oil for account of foreign companies. This step was taken to cover requirements in the Mediterranean and African markets of Socony Mobil Oil Co. Inc., N.Y. This project was received by the Italian Authorities with great favor and rapidly approved. Expansion of the processing capacity was immediately started and by 1952 about 60,000 BCD of crude could be processed. After completion of the new catalytic cracking and reforming units during the period 1955–1958, the capacity is presently about 90,000 BCD or about 4.5 million tons per year, of which 900,000 approximately are processed for Mobil Oil Italiana's domestic requirements. The crude processed is at present almost totally originating from Middle East. If this program of processing crude oil for foreign accounts could be successfully materialized by Mobil Oil Italiana this is not only due to the efforts of this company but also to the excellent understanding shown by the Italian authorities who, immediately real-

(Continued)

ized the advantages for the economy of the country offered by Mobil Oil Italiana's project and gave the company their strongest support.

Mobil Oil Italiana's contribution to the Italian economy

Naples refinery being the first in Italy to process for foreign accounts Middle East crude materialized in this way an actual export of labour and contributed substantially to the national commercial balance. This activity has today provided the equivalent of about 53 million dollars to the Italian economy. Also the traffic of the port of Naples received a great impact from Mobil Oil Italiana's operations since the number of ships calling at this port for unloading crude and for loading products has enormously increased. The port has also many financial benefits deriving from port duties, fiscal charges and custom duties. There are many other hidden benefits such as expenditures for tanker repairs, ship supplies, etc., which are occasioned by vessels calling at this port. The idea of refining crude for foreign accounts was soon followed by the most important foreign and domestic oil companies much to the benefit of the national economy.

Mobil Oil Italiana's distribution network

A further impulse to the development of the Italian company came in 1949, when the decision was taken: to start retailing gasolines and gasoil in addition to the high grade lubricants already distributed in the whole Italian territory. Since 1949 the development of the distribution network increased steadily and at the end of this year Mobil Oil Italiana will have in operation about 1000 Service and Filling Stations throughout the country.

To improve the efficiency of salesmen and dealers in serving the motorists a first training center has been founded in Genoa followed by other training schools which were established in Turin, Milan, Padua, Naples and Rome.

To better serve the public's interest and assist motorists in making the best and most economical use of their cars, Mobil Oil Italiana sponsors the Mobilgas Economy Run, open to national and foreign drivers, which will this year for the first time take place entirely on Italian territory. This interesting sport also has the purpose of demonstrating that good and safe driving as well as the use of a proper fuel and lubricant results in lower gasoline consumption.

Mobil Oil Italiana for the Italian industry

Distribution in Italy of Mobil lubricants started in 1901 and soon Mobil products for industry gained a good reputation for their quality and dependability. This reputation grew over all these years as products constantly improved in quality and also because the consumers are well assisted and advised by the company's well trained salesmen and engineers, who have the benefit of all the experience accumulated by a world wide organization.

The company's basic policy is to prove to industrial customers that Mobil's continuous technical assistance in solving the customers' lubrication problems mean higher efficiency of the equipment and therefore high profits and lower costs. In line with this policy highly specialized technicians of Mobil Oil Italiana, hold training classes at the customers' plants to indoctrinate their personnel on how their equipment should be correctly lubricated, specialized magazines, technical bulletins, clinics and films are successfully used to this purpose. Such services rendered to customers contribute indirectly to the country's industrial development.

This is a brief history of Mobil Oil Italiana and of the company's growth and achievements. It can be understood that a development like this required very substantial capital investments. This was possible because American shareholders have always shown full confidence in the economic and industrial future of Italy. To carry out this wide expansion program Mobil Oil Italiana have in about ten years doubled the number of their employees and more than quintuplicated their payroll. The company takes great care in developing their staffs' skill and ability through training courses and conferences, and by means of a continuous training. A sound and efficient safety program is applied with particular care in Mobil Oil Italiana's operations. The company shows one of the lowest rates of accidents in the whole country. Medical assistance is available to all personnel through specialized physicians and well equipped clinics.

These notes however would not be complete without a particular acknowledgement of the company's personnel. The company today can rely on a highly skilled staff and working force and their loyalty and enthusiasm are the basic factors for Mobil Oil Italiana's successful development.

One of Mobil Oil Italiana's Service Stations.

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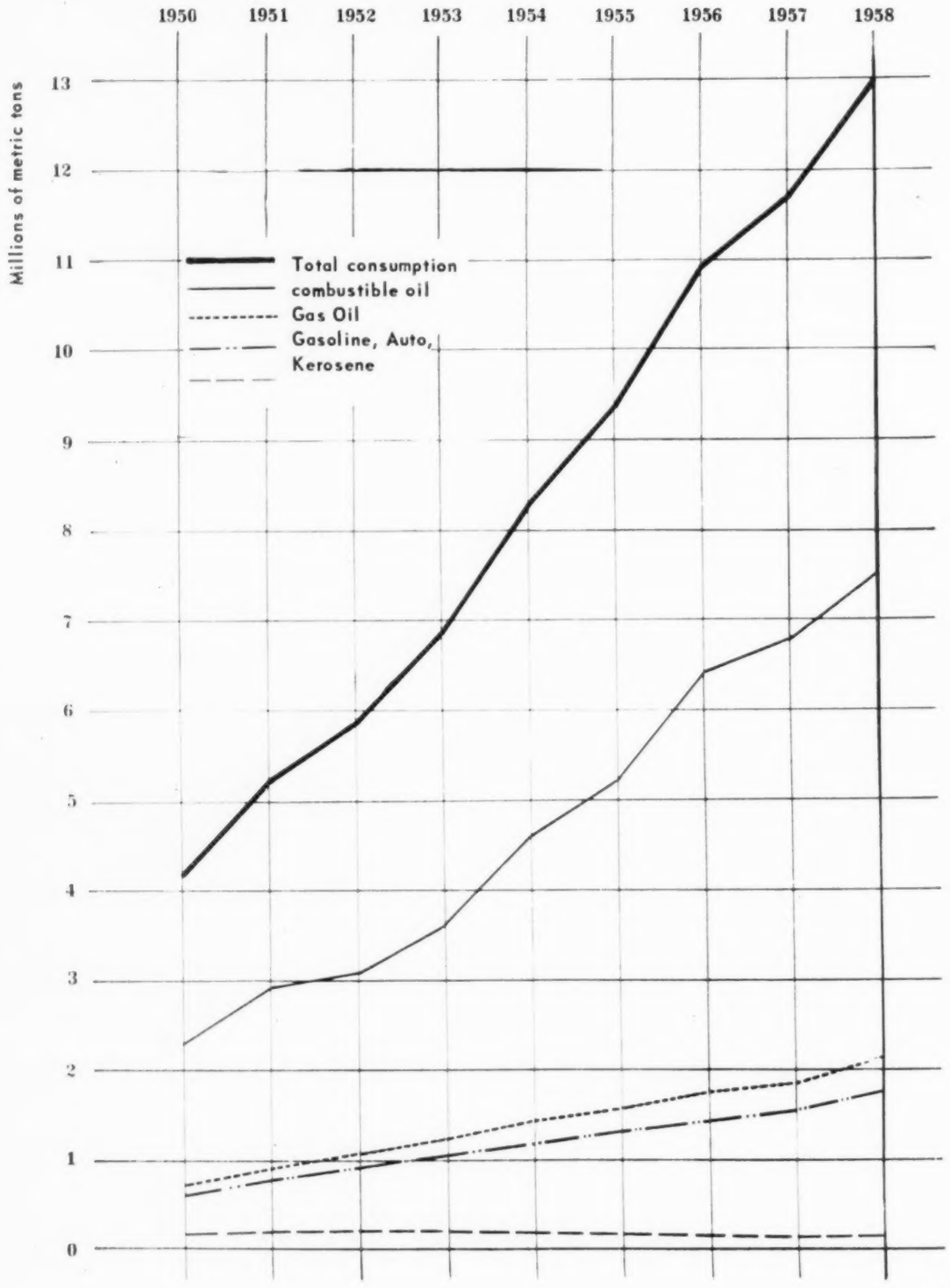
Refining and Distribution of Petroleum Products in Italy

(Continued from Page 15)

Progress of consumption of Petroleum Products in Italy



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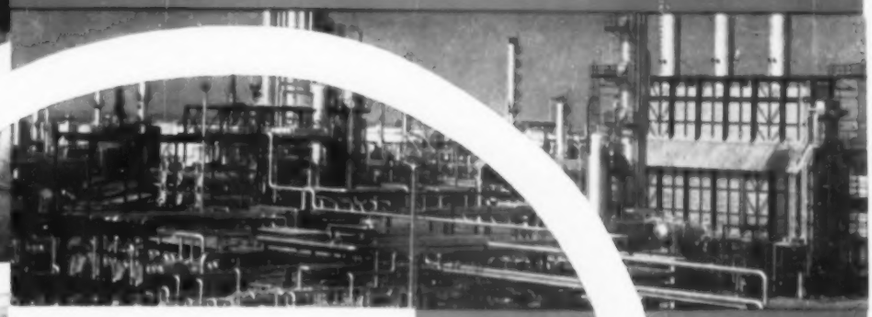

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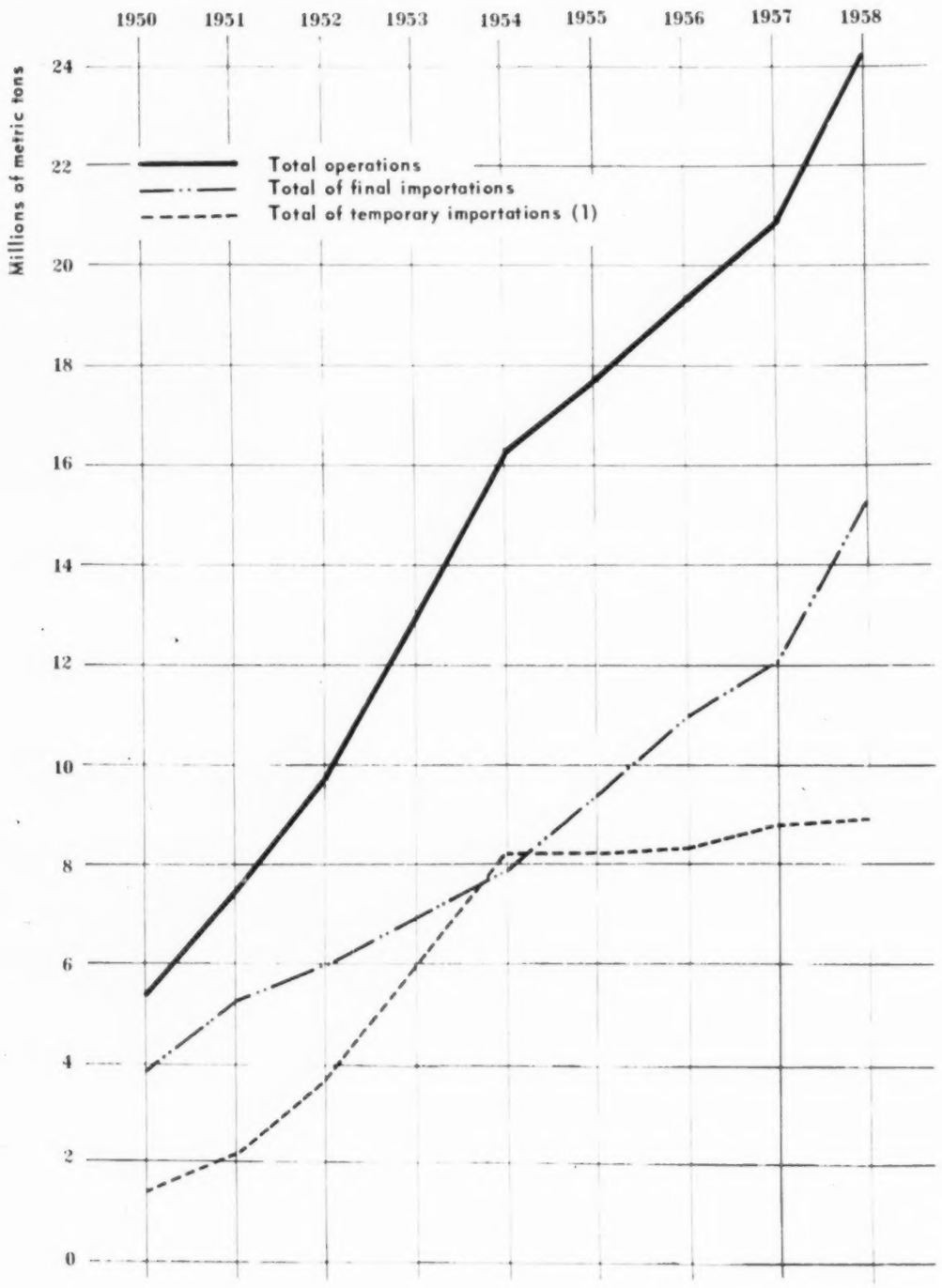
Refining and Distribution of Petroleum Products in Italy

(Continued from Page 18)

Activity of the Italian refineries.

Crude oil treated



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(Continued on Page 21)

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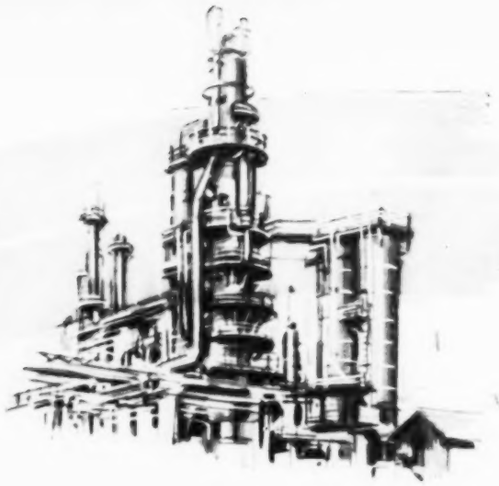

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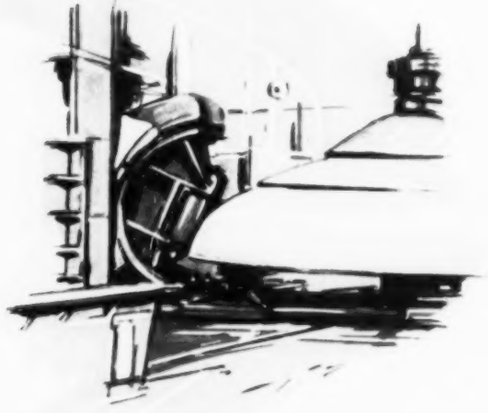

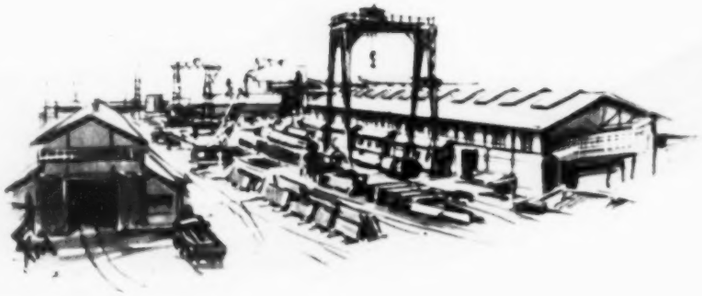

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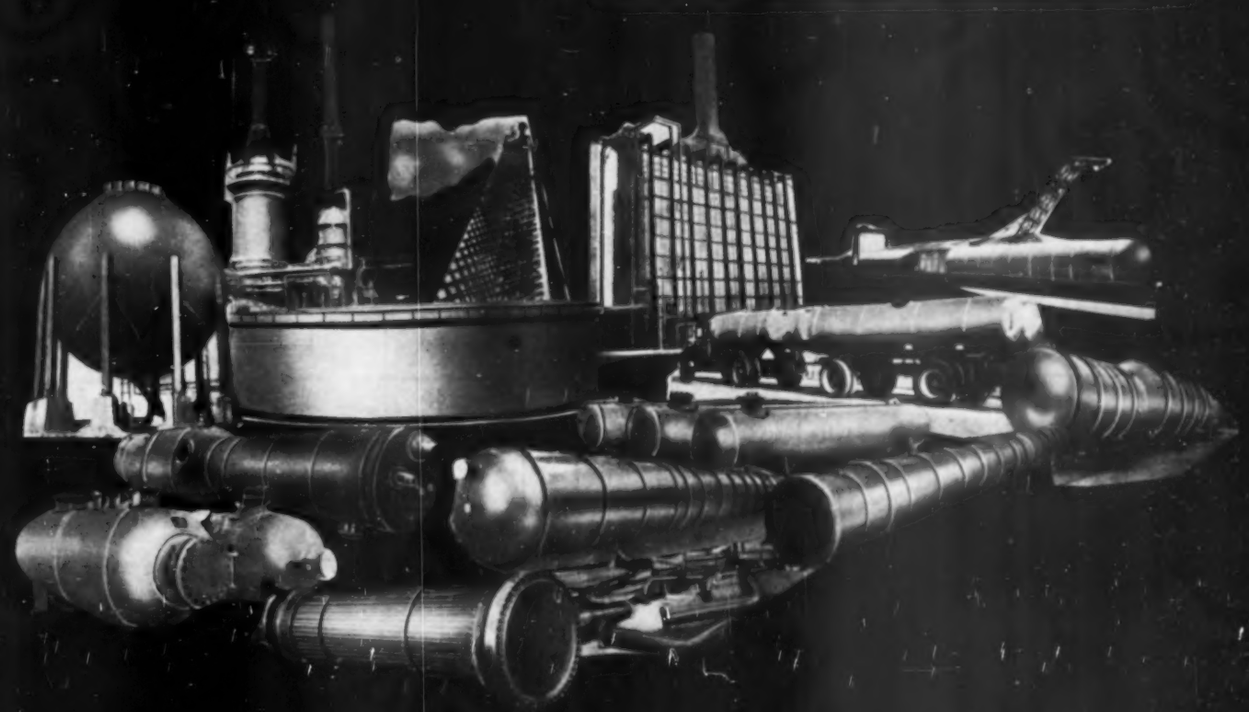

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Refining and Distribution of Petroleum Products in Italy

(Continued from Page 20)

interior market, the importance of the export market, as seen above, has decreased. While in 1954 these two sections of the business stood in the ratio 57:43, today they are in the ratio of about 64.36.

Crude-Oil Supply: In 1954, domestic crude supplied only a nominal amount to Italian refineries, a little over 70,000 tons per year—enough for about 1½ days' processing. During the past year, national crude production (for gasoline exclusively) covered about 1.8% of finished product for the national market, in addition to the more than 200,000 tons it supplied for export.

On the other hand, the supply of crude has continued to increase considerably. Imports in 1954 of 16 million tons mounted in 1956, and in 1958 rose to 23 million tons. The Middle East has remained the principal supplier. However, the relative importance of receipts from that region has diminished slightly—dropping last year to 86.4% if Egypt be excluded. If the latter is classed with the Middle East as a source of supply, the percentage is 91.4%.

Concerning Middle East suppliers, the loss of the Iraq quota should be noted, as well as the relative decrease of Saudi Arabia. The supply of Iran has been somewhat less, and Kuwait has taken the lead. In the meantime, the importance of Egypt has increased, indicating the possibility of further development analogous to the increase in the Russian quota. These foreign sources assured a supply on which the Italian market could depend during the Suez crisis. The eventuality of a forced reduction in the distribution of petroleum may become particularly grave for Italy, where this source covers a balance of energy which is as high, if not higher than, in any of the countries of western Europe. The point is raised because of its importance in bridging this difficult period of preserving full liberty in the consumption of petroleum fuels and of adopting for these fuels only a limited control by the government—its application guaranteeing a reciprocal sense of responsibility between producer and consumer. There should be an equal division between the collaboration of international companies and the operating establishments in the national market, with the fullest possible elasticity in the procedures adopted by the government. As to these procedures and the inflow of substitutes (at a higher cost), it will be appropriate to give assurance to the importers that the major burdens will be assumed by the State. At the same time, the State should be assured of recovering this outlay by the levy of a supplemental tax on gasoline during the critical period, or until parity has been established. On this point there is agreement and dissent, with the former predominating. The majority is of the opinion that the supplement paid by motorists will, in the long run, redound to all consumers of petroleum products.

Considering the large advances made by the Italian petroleum industry during the past few years, the conclusion is warranted that this sector of industrial activity has become more and more important to the Italian economy, and has brought other developments not less interesting. The road to follow will be to facilitate measures in which the political and fiscal economies in Italy will take account of its importance and avoid obstacles to the natural trend. In this vein, the thinking of the operators should accord with that of the organs of international opinion: Both should hold together during the next 15 or 20 years, when new sources of nuclear energy will have begun to manifest themselves, so as to cover the greater demand for energy by Italian production in all its sectors. And the gradual realization of the Common Market starts Italy on a search for a wider economic complex which will have the effect of increasing the demands which will be placed on the Italian petroleum industry.

Energy Consumption in Italy

(000 metric tons)

	fossil fuels	%	methane	%	L.P.G.	%	gasoline	%	kerosine	%	gas oil	%	combustible oil	%	hydro electric power	%	Total power consumption	%
1950	10.289	40 2	571	2 2	38	0 2	960	3 7	280	1 1	981	3 8	3.288	12 9	9.205	35 9	25.612	100
1951	11.471	37 5	1.082	3 5	104	0 3	1.088	3 6	296	1 0	1.182	3 9	4.241	13 8	11.151	36 4	30.615	100
1952	10.500	33 4	1.605	5 1	178	0 6	1.261	4 0	318	1 0	1.391	4 4	4.570	14 6	11.574	36 9	31.397	100
1953	10.598	30 6	2.553	7 4	297	0 9	1.455	4 2	358	1 0	1.645	4 8	5.820	16 8	11.852	34 3	34.578	100
1954	11.211	29 5	3.323	8 7	425	1 1	1.637	4 3	350	0 9	1.851	4 9	6.970	18 3	12.306	32 3	38.073	100
1955	11.475	27 7	4.089	9 9	514	1 2	1.822	4 4	356	0 9	2.057	5 0	8.058	19 4	13.070	31 5	41.441	100
1956	12.128	26 7	5.001	11 0	592	1 3	1.965	4 3	220	0 5	2.268	5 0	9.969	21 9	13.320	29 3	45.463	100
1957	12.431	26 2	5.585	11 8	666	1 4	2.123	4 5	206	0 4	2.443	5 2	10.275	21 7	13.648	28 8	47.377	100
1958 (*)	10.753	21 9	5.799	11 8	776	1 6	2.425	4 9	208	0 4	2.781	5 7	11.193	22 8	15.208	30 9	49.143	100

(*) Preliminary data

– Fossil fuel data expressed as 7,000 Kcal.

– Gross consumption of the plants, excluding bunkers.

NOTE – The data for power consumption from 1950 to 1958 differ from those previously published, but are here used to correlate the fossil fuels with hydroelectric power by a coefficient of 0.4.00.

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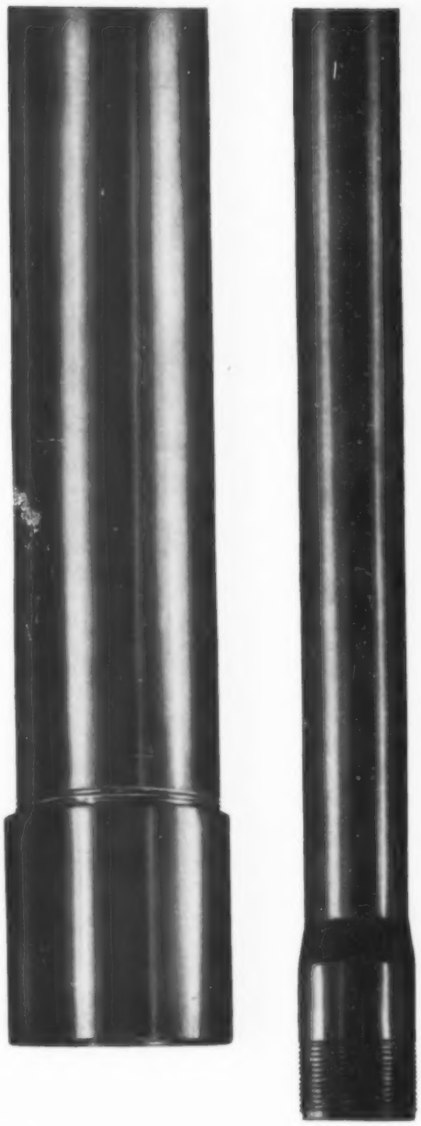

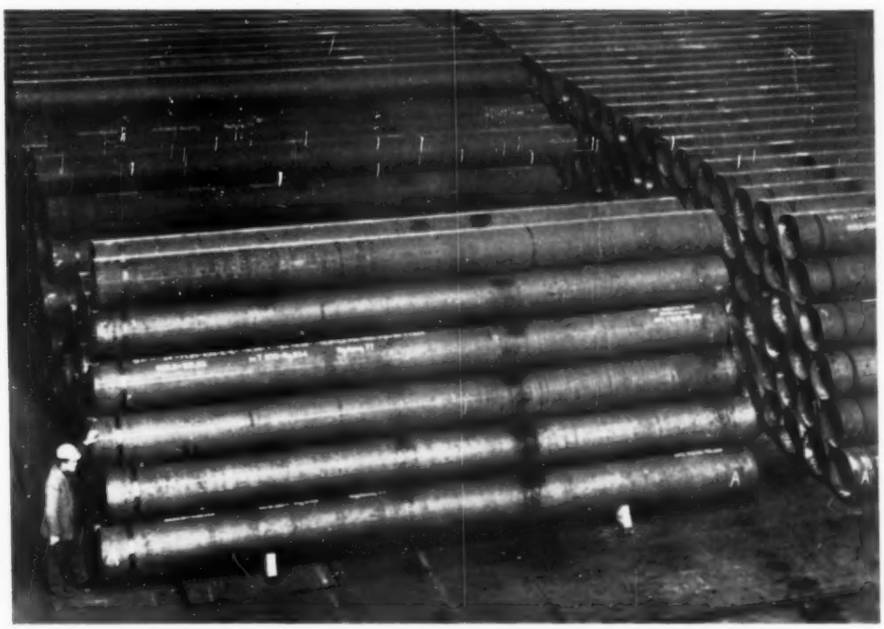

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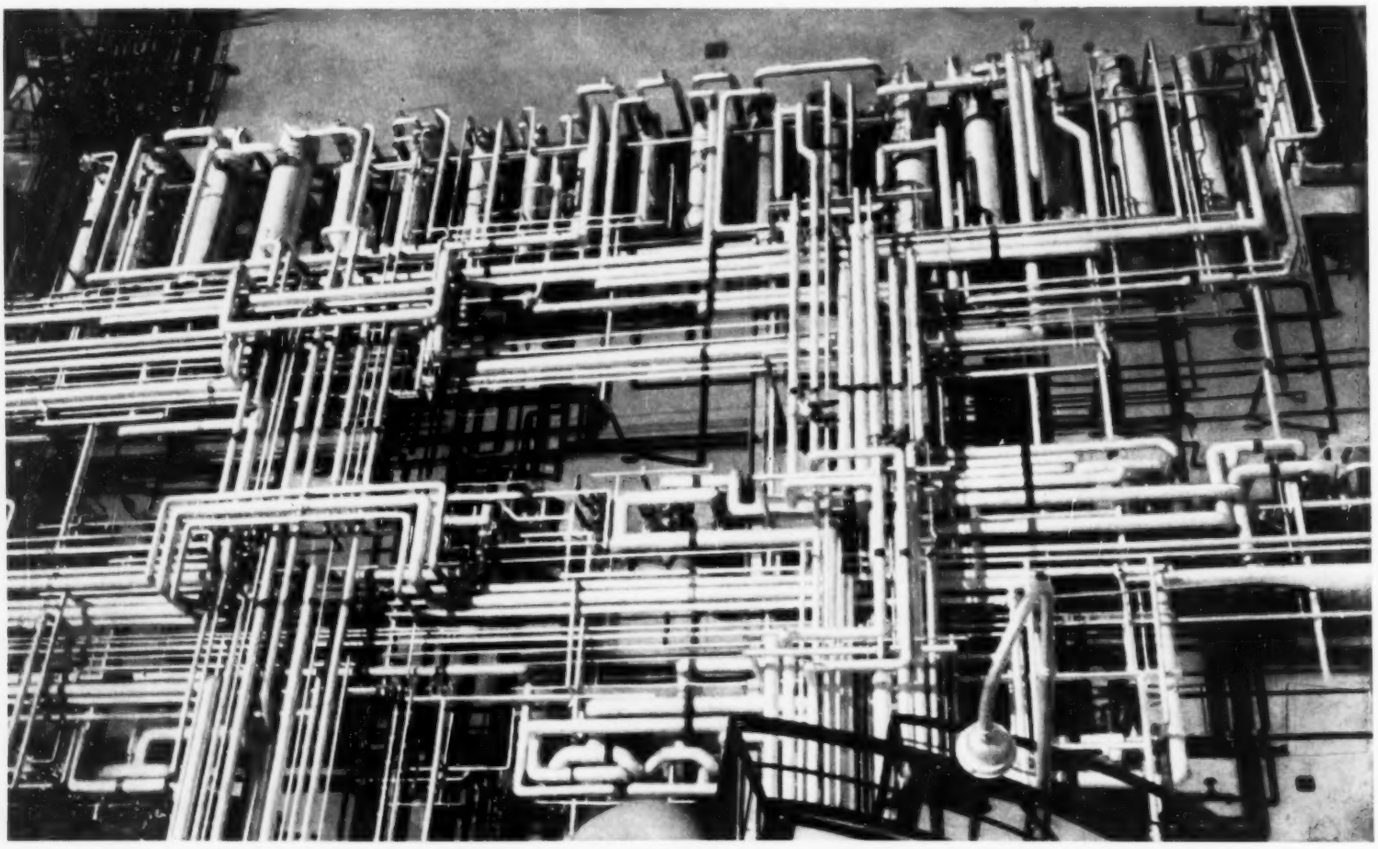

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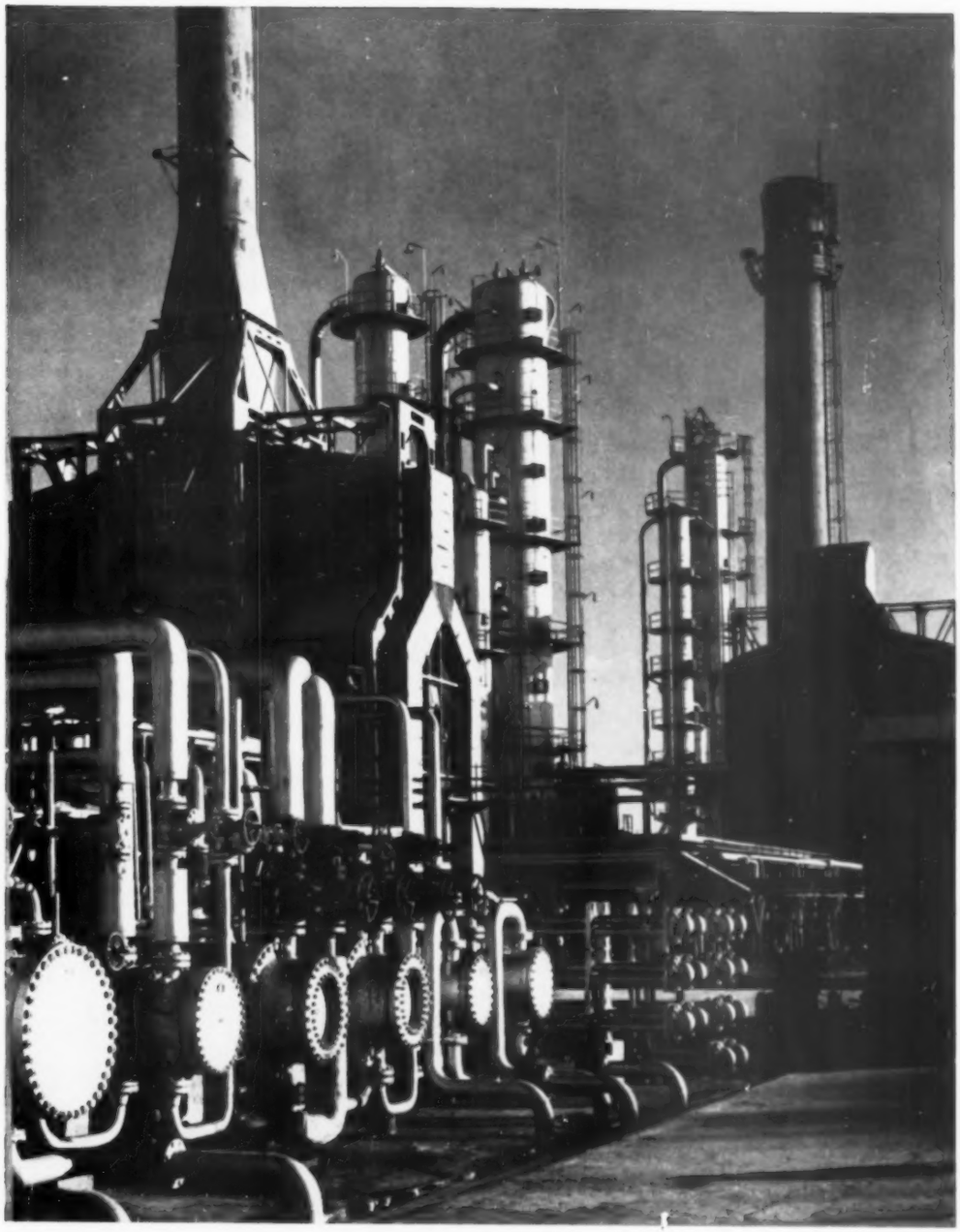

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Temperature is one of the factors which influences most strongly the physical-chemical reaction, especially in the solid phase or in the presence of liquid-solid phases.

Also cement, in its reactions which lead to set and consequent hardening, is greatly influenced by the above mentioned parameter; i.e., with the increase of temperature the low hydration process is quickened.

This occurrence is in contrast with the requirements met in oil well cementing jobs in which the mix must:

a) be quite fluid in order that it may easily be pumped into the casing;
b) be maintained at same state of fluidity for a certain period of time in order that the mix pumped into the casing may flow upwards into the space between the casing and the earth;
c) set not very rapidly in order that the pumping operations may be brought to an end without disturbing the set which would be detrimental to mechanical strength;
d) reach in a short period of time very high mechanical strengths in order to assure perfect impermeability and to permit the continuation of the drilling operations, in the shortest possible time.

It is evident that the problem of the choice of cements is a very delicate one and due to the mutable conditions encountered at various depths (temperature, pressure, nature of the terrain and the waters with which they are in contact) necessitate cements having appropriate and variable characteristics.

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—*GEOCEM Z* recommended for depths over 11,500′ (temperature over 212° F.)

Geocem Cements satisfy the requirements of the API STD 10.A

The above mentioned types, both the "Normal" and the "High sulphate resistant" cements, satisfy the prescriptions of the API Specifications for oil well cements, and cover all anticipated types.

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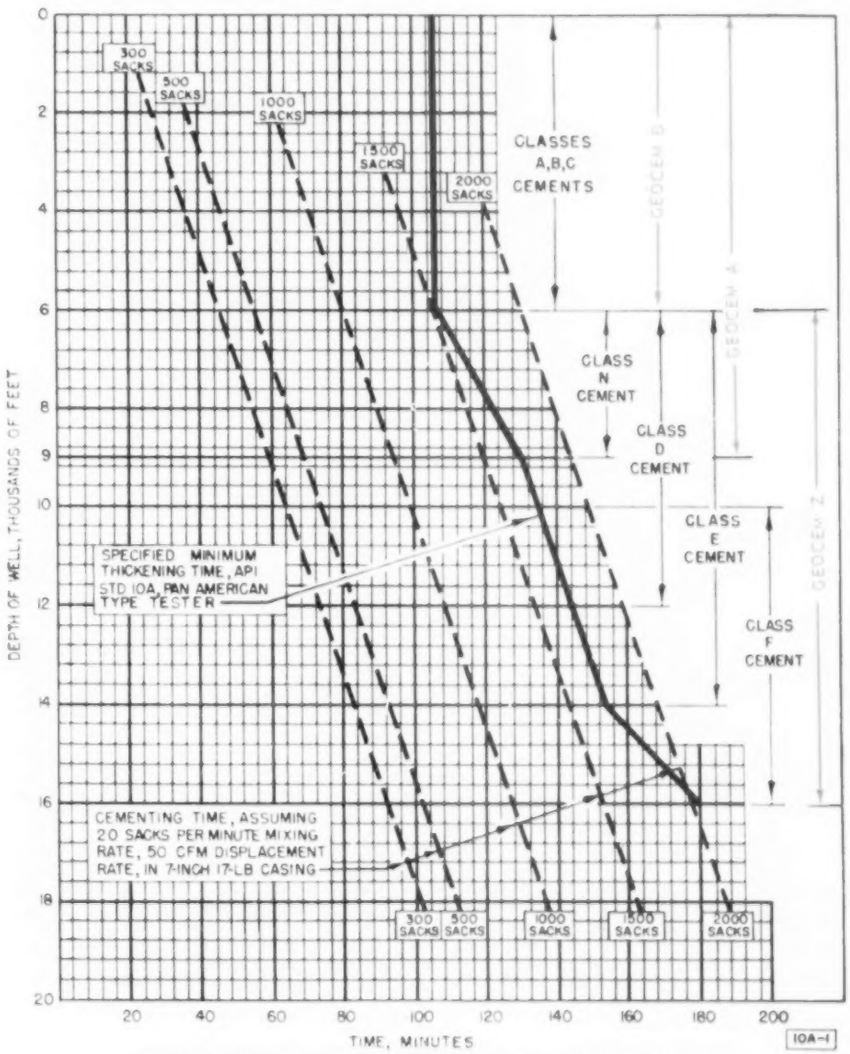

WELL DEPTHS AND CEMENTING TIME RELATIONSHIPS

WITH REFERENCE TO GEOCEM PRODUCTS the chart shows the total cementing times for various quantities of cement, under the conditions as stated; also the thickening time requirements. This information is given herein for the guidance of the user in selecting the cement best suited to a particular job, giving due consideration to the well conditions and the estimated cementing time.

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DRESSER INDUSTRIES, INC.

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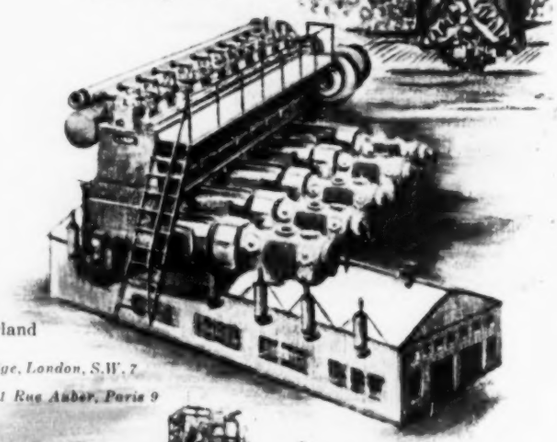
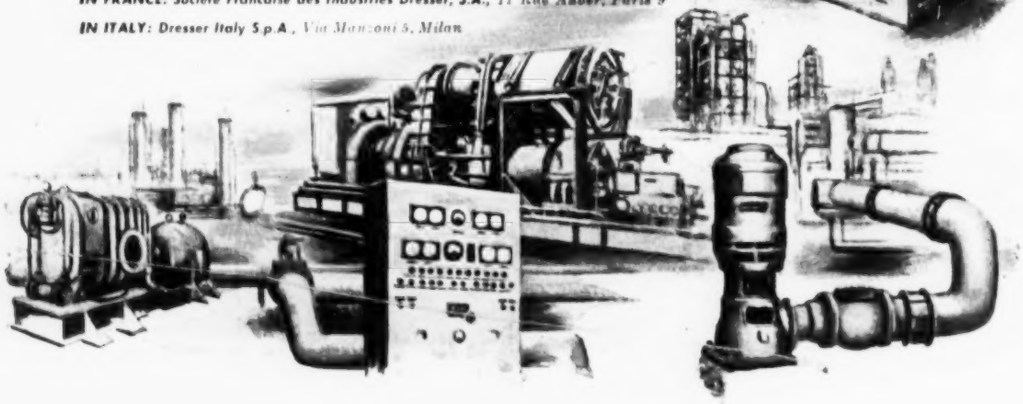


General Representative in the Eastern Hemisphere:

DRESSER A. G.

Mühlebachstrasse 43, Zürich, Switzerland

IN ENGLAND: Dresser (Great Britain) Ltd., *197 Knightsbridge, London, S.W. 7*

IN FRANCE: Societe Francaise des Industries Dresser, S.A., *11 Rue Auber, Paris 9*

IN ITALY: Dresser Italy S.p.A., *Via Manzoni 5, Milan*